CHAPTER 10

LEAD

Lead ranks fifth by weight in domestic metal production, exceeded by steel, aluminum, copper and zinc, in that order. The supply of lead for domestic consumption is derived from three major sources.[1] In 1973 secondary lead contributed 42.0 percent of domestic production, domestic mine output 39.5 percent, and imports 18.5 percent. The excess of 1973 domestic lead consumption of 1,541,209 tons over production of 1,525,328 tons was satisfied by inventory depletion of industry stockpiles.

In contrast to the steel industry which uses both virgin and scrap materials as inputs to the same production processes, virgin and scrap lead inputs are processed separately, often by totally different firms‘. Primary lead ore production is confined mainly to Missouri, Colorado, Idaho, and Utah, though some lead is also produced as a by-product of mining copper, silver, and zinc ores in other states,[2] Lead ores are processed near the mine to minimize transportation costs; smelters and refineries are located in Missouri, Nebraska, Texas, Idaho and Montana. Secondary lead supplies and secondary lead processing facilities are widely scattered throughout the country. The physical separation of the primary and secondary lead sectors is paralleled in differences in output mix. As we note later, the physical and economic separation of the two sectors simplifies econometric modeling of competition between the sectors.

This section is divided into five components:

1) Inputs to secondary lead industry
2) Outputs of the secondary lead industry
3) Outputs of the primary lead industry
4) Discussion of model specification and estimation
5) Evaluation of tax impacts.

I. INPUTS TO SECONDARY LEAD INDUSTRY

Of the three sources of lead scrap - home, prompt, and obsolete - home scrap accounts for about 2 percent of primary production and is included in the primary lead figures; prompt, in the form of drosses and residues, amounts to 15 to 18 percent of secondary lead inputs; and obsolete lead in the form of battery plates, cable lead, babbit, solder, type metal, and soft and hard lead supplies the remaining 82 to 85 percent of secondary lead inputs. The relative importance of various sources of lead scrap is shown in Table 10-1.

Table 10-1. Sources of Scrap Lead

Scrap Source	Tons of Lead Recycled	Percent of Total Scrap
Batteries	350,000	60
Drosses and residues[a]	88,000	15
Lead alloys		8
Type metal	29,000	
Bearing metal	10,000	
Solder	9,000	
Cable sheathing	32,000	6
Ammunition	5,000	1
Miscellaneous obsolete scrap	62,000	10
TOTAL	585,000	100

a Drosses are metallic substances which are skimmed off the surface of molten metals.

Source: National Association of Secondary Materials Industries, Inc., Lead, 1969, p. 213. (Hereafter termed NASMI Report)

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The estimated life cycles of various sources of lead scrap are shown in Table 10-2:

Table 10-2. Sources, Life Cycles and Recycling of Lead

Sources	Life Cycle (years)	Percent of Available Lead Recycled
Batteries	2.3	72
Drosses and residues	0.1	100
Lead alloys		
Type metal	2.0	100
Bearing metal	20.0	30
Solder	20.0	14
Cable sheathing	40.0	25
Ammunition	0.5	6
Miscellaneous obsolete scrap	30.0	62

Source: NASMI Report, p. 212

Using these figures, the quantities of lead theoretically available for recycling in 1969 was determined. For example, lead sheathings for cable are used for approximately forty years before they are scrapped. The quantity of lead used in the production of cable sheathing in 1929 is the approximate amount available for scrapping in 1969. Once the figures of lead available for recycling are calculated, the percentage of available lead actually recycled in 1969 can be obtained. These are also provided in Table 10-2.

Only six percent of the available ammunition lead available in 1969 was recycled. This low rate of recovery is attributable to difficulties encountered in collecting the shot from areas where it is relatively concentrated. Unless the price of lead rises considerably, recycled ammunition will continue to originate only at target ranges.

The percentages of the available lead based alloys, bearing metals, solders, and type metals, which are recycled, vary over a wide range. The greatest single use of lead alloys is type metals used in printing plates for type making purposes. Nearly 100 percent of type metal scrap is recycled. Lead-base alloys used as bearing surfaces for rotating parts are usually a small constituent of a much larger system of other materials. For example, an automobile engine contains a small amount of lead in the bearings. Just as it would not pay to disassemble an auto engine for its lead bearings, it is not economically feasible to recover 70 percent of the theoretically available bearing lead. This condition is likely to remain unchanged in the future.

Only 14 percent of available solder scrap is recycled because, in most uses, the lead becomes intimately attached in tiny quantities to much larger quantities of other materials such as copper and steel. Collection of this lead depends on the value of the metal to which the lead is attached. In a minority of cases, it is economically feasible to separate the solder from the other material. The NASMI report claims that this is an area with some room for improvement in recycling.

Approximately six percent of scrap lead is from lead cable sheathing. Before it is ready for the smelters, lead cable has to be passed through a cable stripping machine which cuts the lead sheathing and peels the inner core of the cable. The stripped lead cable covering is then cut into small enough pieces for feeding into the smelting pots. To facilitate ease of handling, it might also be compressed in a hydraulically operated press.

Seventy-five percent of the scrap lead cable sheathing theoretically available in 1969 was not recycled. This type of lead scrap is economically feasible to recycle, so it is difficult to explain why so little has been recovered. Part of this may be explainable by errors in reporting by secondary scrap processors and smelters. Error is also introduced by basing the quantities available for recycling on life cycles. And finally, some lead sheathing is very likely reported in the "Miscellaneous obsolete scrap" category. However, it is difficult to see how such errors can account for more than one-half of the apparent loss of cable sheathing scrap, and so this is a category in which an increase in the recycling rate of lead is possible.

Ten percent of the total scrap used by the secondary lead industry in 1969 was from miscellaneous obsolete scrap. This figure represents 62 percent of the scrap theoretically available for recycling. Miscellaneous obsolete scrap, like solder scrap, includes a wide variation in the types of application so that some lead (weights and ballasts, sheet, pipe and fittings) is easily recyclable while others (foil, collapsible tubes, terne metal) are economically prohibitive to recover. The recycle rate for miscellaneous obsolete scrap is relatively high and, as in solder scrap, it is unlikely that more than a minor amount of additional lead. can be expected to be recycled.

Battery lead plate is by far the largest single source of lead scrap, accounting for 60 percent of the total lead-base scrap smelted in 1969. Although automobile batteries are the most commonly used source of battery scrap, other used batteries come from railroads, industry, farms and military demolition. During 1969, 135,000 tons or 28 percent of battery lead theoretically available for recycling was not recycled. This is quite a high figure, given the fact that battery recovery is generally economically attractive. As in lead cable sheathing, these apparent losses of battery scrap may in part be due to error in reporting: some of the battery lead scrap maybe included in the figure under “Miscellaneous obsolete scrap", and/or scrap processors may be giving incomplete figures. The method of using life cycles of the scrap metal to estimate the theoretical availability of a particular scrap is probably not likely to be as inaccurate for battery scrap as it is for cable sheathing scrap since the life span of batteries is substantially shorter. At any rate, the NASMI report estimates that error in reporting cannot account for more than one-fourth of the loss of battery scrap lead. This would mean that the actual loss of battery lead scrap would still be more than 100,000 tons in 1969. The report explains some of these losses by storage losses in private homes and garages, military battery losses, and discards into trash collection channels. It is conceivable that the losses in battery lead scrap is a promising area for increased recycling.

II. OUTPUTS OF THE SECONDARY LEAD INDUSTRY

Two operations process scrap lead into intermediate products. The reverberatory furnace accepts a charge of battery plates, drosses, residues, and other lead scrap, and yields as outputs crude semi-soft lead and a leady slag. The blast furnace may be used to process slag from the reverberatory furnace, recycled slag from a blast furnace, drosses, oxides, and battery plates into hard, antimonial lead.[3]

rot furnaces enable the crude semi-soft lead produced by reverberatory furnaces and the hard antimonial lead produced by blast furnaces to be brought to desired residual alloying percentages.[4] When commencing with a metal containing less residual alloy than is desired, additional alloying materials are added directly to the pot furnace. When the residual contamination of antimony and copper in semi-soft lead is undesirably high, sulfur is added to the molten alloy in a pot furnace and the mixture is stirred. Copper sulfide is skimmed off as a dross. Antimony may be removed by bubbling air through the molten lead.

When the residual alloy contamination of scrap can be controlled, processing in pot furnaces may be unnecessary. For example, the hard lead produced by a blast furnace will contain sufficient antimony to be used directly as an input to new battery plate production, provided such antimony rich inputs as battery plate and reverberatory furnace slag are fed to the blast furnace.

The relative importance of various markets for secondary lead is given in Table 10-3.

Table 10-3. Markets for Secondary Lead

Secondary Lead Markets	Percent of Total Market(l970)
Batteries	70
Tetraethyl lead	13
Solder	5
Type	4
Cable	3
Other	3
Bearings	2

Source: Derived from figures in NASMI Report, p. 213.

Storage batteries account for about 60 percent of scrap lead inputs. An approximately equal percentage of outputs of the scrap lead sector is devoted to the production of grids and paste for storage battery plates. Because of the overwhelming importance of storage batteries to the secondary lead industry, the recycling of storage battery plates will be analyzed in some detail here.

The typical automobile battery contains about twenty pounds of lead, most of which is found in the battery plates. The plates are composed of an antimonial lead grid whose interstices are filled with a lead oxide paste. A plate contains about half hard lead (antimony content ranging from 7 to 12 percent), and half soft lead oxide paste (less than one percent antimony).

Plates which have been removed from spent storage batteries may be smelted in a blast furnace or processed in a reverberatory furnace. The blast furnace is more efficient and is normally used when antimonial lead is the desired output. To produce a hard lead output, additional antimony must be fed to the blast furnace for the antimony content of an entire plate averages only four to five percent antimony, or some three to seven percent less than is required in antimonial lead.

Plates melted in a reverberatory furnace yield about one-half soft lead and one-half lead antimonial slag. The slag requires further smelting in a blast furnace to recover the lead.

Antimonial lead produced by the blast furnace may be used directly in the manufacture of grids for new battery plates. Normally the grids are cast by pouring molten lead into an iron mold and allowing it to solidify. Litharge, the lead paste for battery plates, is a mixture of lead oxide (obtained by oxidizing soft lead in a furnace), finely divided metallic lead, and water.

III. OUTPUTS OF THE PRIMARY LEAD SECTOR

The primary lead industry mines ore, concentrates the ore, and processes lead concentrates in blast and pot furnaces.[5] The principal source of lead is galena, a lead sulfide. In addition to sulfur, galena usually contains appreciable quantities of zinc and antimony. Normally lead ores require concentration through differential flotation or a similar process before they are smelted. Smelting burns off the sulfur (oxidation), and reduces lead oxides to metallic lead. Pot and kettle furnaces are used to add or remove other metals in a process known as refining.

Most lead bearing ores contain significant quantities of other metals. The Missouri ores, the source of about three-fourths of domestic production in recent years, contain about one part zinc for every six parts lead. Many Idaho ores contain lead and zinc in roughly equal concentrations as well as significant quantities of silver. Colorado lead ores typically contain more zinc than lead as well as copper in concentrations justifying its separate recovery.

After a long period of decline which began in 1950, primary lead output nearly doubled in the five years from 1967 to 1972. A three-fold expansion of Missouri output accounted for all of the recent increase as production shifted from the Old Lead Belt to the New Lead Belt fifty miles to the west.

Although lead ores contain antimony in appreciable quantities, and would therefore appear ideal for the manufacture of hard lead outputs, most lead is refined in pot furnaces to produce soft lead. Less than two percent of the output of the primary sector is hard, antimonial lead. Soft. refined lead has a wide variety of end uses,including the gasoline additive tetraethyl lead, cable sheathing, lead oxides, pigments, and a variety of lead alloys.

IV. MODEL SPECIFICATION

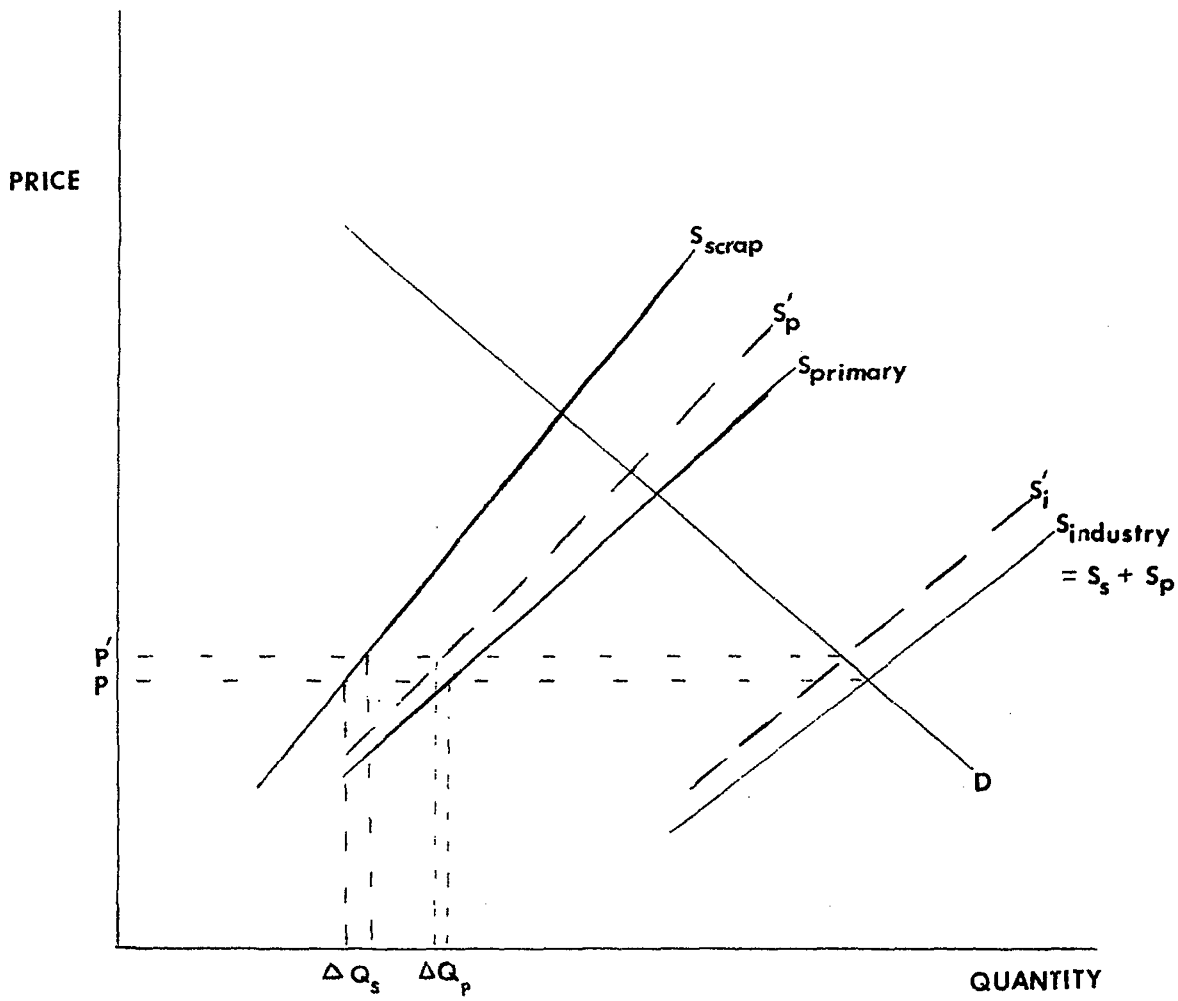
The discussion of lead industry outputs revealed that primary and secondary sector outputs are substantially identical, but proportion of total output devoted to antimonial lead, soft refined lead, and lead alloys varies considerably between the two sectors. This indicates that cost increases in the primary sector would make the primary sector relatively less competitive and could induce a substantial shift in the quantities supplied by the two sectors in the long run.

The relevant analytical model for predicting the long run impact of altered cost conditions in primary production assumes primary and secondary outputs are perfect substitutes and can be linearly added to form the lead industry supply curve. The intersection of supply and demand determines the equilibrium price for lead outputs. A tax induced shift in the hypothetical primary industry supply curve (as depicted in Figure 10-1) shifts the industry supply curve, and hence changes market price. The new equilibrium quantities supplied by each sector can be read from the graph. In Figure 10-1 the upward shift in the primary sector supply to S'p results in a new equilibrium price of P', an increase in secondary lead output of ΔQ_s and a reduction in primary lead output of ΔQ_p.

The key to the empirical analysis of the market model is to develop long run parameter estimates for sectoral supply curves and for the industry demand curve.

FIGURE 10-1

SUPPLY AND DEMAND FOR LEAD



A. Primary Production

Mine production of lead was modeled in terms of distributed lags with mine output being influenced by past as well as present independent variables. We used the Koyck distributed lag model, which can be derived from a stock adjustment hypothesis as follows.

Denote the quantity of lead supplied in year t by Q_t and the price received by producers by P_t. Let Z_t represent the price of the co-product, zinc in year t. Given these prices, producers would like to furnish Q^*_t which depends on prices according to the long-run supply equation

$$Q^*_t = a + bP_t + cZ_t \tag{18}$$

Since it requires time for supply to reach the desired level, producers do not immediately offer Q^*_t in response to new values of price. If it is assumed that it is only possible to adjust by some fixed fraction θ of the desired amount in any year, then

$$Q_t - Q_{t-1} = \theta(Q^*_t - Q_{t-1}) \tag{19}$$

Substituting (19) into (18) and rearranging

$$Q_t = \theta a + \theta bP_t + \theta cZ_t + (1-\theta)Q_{t-1} \tag{20}$$

In this model the short-run effect of price on supply is given by θb, and the long-run effect is given by b directly. The smaller is θ, the slower the rate of adjustment and the greater the difference between long-run and short-run effects.

The estimation of equation (20) by ordinary least square encounters two difficulties. First, both prices are endogenous to the model (though the price of zinc could be assumed exogenous) and biased coefficients are to be expected unless two stage least squares or a similar estimating procedure which recognizes the simultaneous nature of P_t and Q_t is used. Second, if the error term in the equation is autocorrelated the estimates will be inefficient. Autocorrelation is quite likely in such a model and can be treated only by assuming a specific order of the relation among the errors. The computation algorithms available to project researchers limited us to a first order autocorrelation model. Denoting the error term in

(20) by u_t we assumed

$$u_t = pu_{t-1} + e_t \tag{21}$$

where e_t was assumed to have mean zero and variance-covariance matrix $\sigma^2 I$. Equation (20) was estimated by choosing estimates of p and other parameters to minimize the sum of squares of e_t. As noted by Cooper, the estimator is consistent and if e_t is normally distributed also a maximum likelihood estimator.[6]

Data for the equation were taken from Minerals Yearbook. Mine production, Q_t, is mine output of primary lead in thousands of short tons, and price, P_t, is the producer price of lead in cents per pound divided by the U. S. wholesale price index (1957-1959 = 100). The supply equation was estimated by two stage least squares using as predetermined variables: the price of zinc lagged once and twice, the Federal Reserve Index of industrial production, and a linear trend. Primary supply is:

$$Q_t = -4.19 + \underset{(4.21)}{11.58P_t} + \underset{(3.70)}{.45Q_{t-1}} \tag{22}$$

$p = -.002$

Years: 1949-1967

In this equation the figures in parentheses are the t ratios of the estimated coefficients to their asymptotic standard errors. Small sample tests of significance have not been developed for such estimates, but others have assumed that a t ratio of 2 or more indicates a statistically significant relationship (see Fisher et. al.)[7] As indicated, the years from 1968 on have been omitted, primarily because the doubling of national primary lead output from 1967 to 1972 following development of the New Lead Belt in Missouri was related more to technological factors than to changes in market price or demand. The price of zinc proved to be insignificant and was dropped from the primary supply equation.

The speed of adjustment in primary lead supply is fairly rapid. Over half (1.00 - .45) of the gap between desired and actual production is achieved each year. Thus, the difference between short and long-run supply elasticities is relatively small. At the point of means for the period the short run price elasticity of supply is about .55 and the long-run elasticity is about 1.0.

B. Secondary Production

The principal sources of secondary lead are recycled battery plates, drosses, and residues, and miscellaneous collections of recyclable cable sheathing, solder and type metal. All attempts to formulate a distributed lag model of secondary output produced negative, albeit insignificant, coefficients for the lagged dependent variable. This could be explained if high output in one period tends to deplete the inventory of obsolete scrap available for recycling in subsequent periods. The conspicuous failure of the distributed lag approach led us to model secondary output, S_t, as a function of current price; P_t, lagged battery production; B_{t-2} to represent availability of scrap; and current primary production, R_t, which is a possible source of drosses and residues.

The supply equation was estimated by two stage least squares using as predetermined variables the once and twice lagged price of zinc, the Federal Reserve Index of industrial production, and a linear time trend. Both primary production and lagged primary production proved insignificant and were dropped from the equation. Secondary supply was estimated as:

$$S_t = 27.29 + \underset{(7.49)}{18.23P_t} + \underset{(18.1)}{2.98B_{t-2}} \qquad (23)$$

Years 1954-1972

As with primary production, output is in thousands of tons, and price is in cents per pound. Battery production is the Federal Reserve Index of replacement storage battery production, 1967 = 100. The fit for the equation is quite good. At the means for the period the estimated elasticity of output with respect to price was .48. The equation excluded the years prior to 1954 because the Federal Reserve Index of battery production began that year.

C. Consumption

The more significant end uses of lead are storage batteries, tetraethyl lead, pigments, type. metal, cable sheathing, ammunition, and bearing metal. The level of demand for many of these end uses appears to be closely linked with general industrial activity. Others, principally storage batteries and tetraethyl lead additives, appear to be related to the ownership and use of automobiles. Because the production of storage batteries and gasoline additives are components of general industrial activity, it would not be appropriate to include in the demand equation both an index of industrial production and a separate index of gasoline or battery output as determinants of lead consumption.

Other variables which could be important determinants of demand are the price of lead, the price of lead substitutes, and measures of the stock of lead held in inventory of semi-manufactured goods. Clearly, the price of lead should be included in any specification of demand, but just what constitutes a lead substitute and measures of lead held in manufactured goods inventories are difficult to determine. Lead has substitutes in battery production, including the metals nickel and cadmium, but all substitutes are far more expensive and are reserved for special applications where low weight or long life are critical. A similar situation pertains to other lead uses; with the exception of cable sheathing, where substitutes exist they are considerably more expensive. Substitution of other metals for lead in the past twenty-five years may have occured in response to technological change or to avoid potential lead poisoning of humans, but substitution in response to changes in lead prices has probably been insiginificant, given that lead has been far cheaper than substitute materials during this period. Because there are no data on inventories of fabricated products embodying lead, and other data series which were available, such as durable goods inventories, are poor measures of this form of lead in inventory, the inventory aspect of lead demand was not included in the econometric demand specification.

The demand equation was first formulated in terms of distributed lags in which the current value of consumption depended on current and past values of the independent variables. When this failed (the coefficient of price was positive and that of lagged consumption negative) the equation was specified in terms of contemporaneous values of all variables. The demand equation was estimated by two stage least squares using as instruments the lagged values of price, secondary production of lead (once and twice lagged), the lagged value of consumption, and the lagged value of industrial production.

In the equation reported below, consumption, C_t is in thousands of tons; price, P_t, is in cents per pound; and industrial production is the Federal Reserve Index of industrial production. Consumption and price data were taken from the Bureau of Mines' Minerals Yearbook. Price data were divided by the wholesale price index (1967 = 100). The Durbin Watson statistic was low in the original equation, and, therefore, the serial correlation correction discussed previously was used in the final round of estimation. Demand was estimated as:

$$C_t = 711.3 - \underset{(2.62)}{17.31P_t} + \underset{(4.94)}{10.23I_t} \tag{24}$$

ρ (the serial correlation coefficient) = .938

Years: 1949 - 1972

At the means for the period the price elasticity of demand was estimated as .21, indicating that consumption is largely unresponsive to changes in market price. This is to be expected for an input that is low in value relative to the final output price (as it is in pigments, gasoline additives, and bearings), or has few or no substitutes at present price levels (as in storage battery production).

V. EVALUATION OF TAX IMPACTS

In this section we use the econometric results to estimate the impact of virgin material tax preferences on incentives to recycle scrap lead products. The estimates assume the virgin lead supply curve is shifted by the full amount of the tax, that is that all taxes and subsidies are passed forward into product prices.

One of the assumptions underlying the computation is that we have captured the entire lead supply by estimating mine output and secondary production. Since lead imports have ranged from about 15 to 25 percent of total consumption in recent years, this assumption is clearly violated. On the other hand if lead imports do not respond to changes in the price of lead this segment of supply may be ignored. To test the relationship between lead imports and the price of lead a separate import equation was estimated. In all specifications the price of lead was insignificant leading us to drop imports from further consideration in the computation of industry supply elasticity.

Referring again to Figure 10-1 and to the estimated elasticities, we may calculate the impact of an increase in the price of virgin lead output attributable to removal of the mineral depletion allowance on the quantity of scrap lead recycled. The elasticity of the industry supply curve is equal to the weighted average of primary and secondary elasticity, or .6. The supply curve for final lead outputs is shifted by .4 percent for every one percent increase in the supply curve for primary lead. As indicated in Chapter 6 (page 111), the maximum impact of percent depletion on the primary supply curve is about 5.3 percent. This suggests that elimination of percent depletion would increase the lead industry supply curve by at most 2.1 percent. The equilibrium price, of lead would rise by an amount equal to the product of the percent shift in supply and the supply elasticity, divided by the sum of supply and demand elasticities (see page 88 for details). If percent depletion results in a shift of primary supply of 5.3 percent, the equilibrium price of lead would rise by 1.6 percent and the consumption of scrap lead would rise by 1.6 percent times the scrap supply elasticity of .48 or 0.75 percent. The other tax preferences, such as expensing of exploration and development would have even smaller impacts.

CHAPTER 10

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CHAPTER 11

COPPER

Copper ranks third by weight in domestic metal production behind steel and aluminum. The secondary copper industry is the largest of the non-ferrous secondary metal industries. In 1972, secondary copper production amounted to 1479 thousand tons, of which about two-fifths was old or obsolete scrap and three-fifths was new or prompt scrap.[1] The total represented approximately 42 percent of the total supply of copper for that year.

Primary copper production from the states of Arizona, Utah, New Mexico, Nevada, and Montana, accounts for over 90 percent of primary domestic copper production.[2] A few large corporations dominate the primary copper industry. Although the same firms are also factors in the secondary copper industry, their share of output is much lower. Primary and secondary copper substitute at a number of different points in the materials flow of the industry, making accurate econometric modeling of competition between the two sectors virtually impossible. In this Chapter we took two alternative approaches. One was to attempt to identify those points where substitution of primary and secondary copper actually occurs, and base the econometric estimates of supply and demand on the quantities observed at the points of substitution. The second was to assume that in the long run there would be perfect substitution between the final outputs of the primary and secondary copper industries, and estimate the supply equation for all obsolete scrap. Of the two approaches the second should provide the more optimistic assessment of the impact of increasing the tax burden of primary producers on the quantities of scrap copper recycled.

The chapter is organized into five sections:

1) Inputs to the secondary copper industry
2) Outputs of the secondary copper industry
3) Outputs of the primary copper industry
4) Discussion of model specification and estimation
5) Evaluation of tax impacts

I. INPUTS TO COPPER INDUSTRY.

Almost half of the secondary copper recovered is classified as obsolete scrap. In 1969, 44 percent of all copper scrap recycled was obsolete scrap, with the remainder obtained from prompt industrial scrap.[3] Table 11-1 below shows the major identifiable material sources of copper scrap, as well as the amounts of copper recycled from that source as both prompt and obsolete scrap.

Table 11-1. SOURCES OF SCRAP COPPER

Source	Copper content recycled (1000 short tons)	%of total	% Prompt	% Obsolete
. Electric Wire and copper	699.1	54	54	46
Cartridge brass	128.2	35	59	41
Automotive radiators	48.5	3	-	100
Low grade scrap and residues	37.2	3	100	-
Other scrap	18.9	1	68	32
Railroad car boxes	20	1	-	100
Magnet wire	13.5	1	-	100

Source: Battelle Memorial Institute, A Study to Identify Opportunities for Increased Solid Waste Utilization, Volumes II to VII, 1972, p. 146 (hereinafter referred to as "Battelle Report")

Prompt scrap usually is a material of known composition and is relatively free from impurities. These qualities are very desirable to consumers and it can be assumed that virtually all the available prompt scrap enters supply channels and is recovered.

Obsolete scrap is more complex. Copper products become potentially available for recovery once they enter the market. However, the year in which each end-use quantity becomes available for use as scrap depends on when the product becomes obsolete. This is determined by each product's life cycle. By applying the average life cycle for products in various market categories to historical consumption data, an estimated figure for the "potential supply" of obsolete copper scrap may be obtained. Table 11-2 shows the potential annual availability for several major identifiable material sources of scrap copper as well as the percentages of scrap actually recovered in each category.

Table 11-2. POTENTIAL AND ACTUAL COPPER RECYCLING FOR MAJOR END USES

Material source	Life cycle	Available (in 1000 short tons)	Percent recycled	Percent prompt recycled	Percent obsolete recycled
Low grade scrap & residues	5	37.2	100	100	-
Other scrap	?	18.9	100	100	-
Automotive radiators	12	53.0	91	-	91
R.R. car boxes	3.5	22.6	88	-	88
Wire & tube	45.0	850.9	82	100	68
Cartridge brass	.5	204.9	63	100	31
Other brass	30.0	1,013.3	52	100	30
Magnet wire	10.0	158.	9	-	0
Alloying additives	14.0	96.9	0	-	-

Source: Battelle Report, p. 146.

On weighted average, the life cycle of all copper products is approximately 17 years, and about 40 percent of the total obsolete scrap available is actually recovered.

Of the total copper contained in an automobile, about 10 pounds is found in the radiator. This item is relatively easy to remove, and the recovery rate from this source of copper is high. In addition, the amount of copper potentially available from this source represents only a small percentage of the total obsolete scrap available. Even if all of the 4.5 thousand tons of copper scrap in automotive radiators that are presently not recycled were recovered in response to a price change, this would still represent less than a one-half of one percent increase in supply.

The same is true for copper scrap from railroad car boxes. The rate of recovery of secondary copper from this source already is high; and even if all of the copper from this source were to be recycled, it would increase the total supply of obsolete copper by only one fifth of one percent.

Two of copper's properties, its electrical conductivity and ductility, explain its wide use as an electrical conductor in the form of wire. Silver is the only metal whose electrical conductivity is better than that of copper, but its added cost does not justify its widespread use in electrical applications. Recycled copper wire and tube is a large source of copper scrap, and any increase in the 82 percent of copper wiring already recycled will significantly add to the total supply of copper scrap.

The main applications for copper falling in this category include insulated communication wire and cable, power wire and cable, plumbing tube for buildings, and insulated appliance wire.

Nearly 100 percent of the copper cable used by utilities and phone companies is already recycled.

Formerly, most of the copper scrap from houses and other buildings was recovered as demolition waste when the building was torn down. But with the increasing costs of semiskilled labor, there has been an incentive for the demolition contractor to consider copper salvage to be uneconomic and, as a result, dispose of scrap from this source in dumps or sanitary landfills.

Most cable and wire has been insulated with either lead, paper, rubber, cloth, asbestos, or polyethylene. The problem of removing this insulation has become more complicated by the trend towards more stringent air pollution control. Incineration is the traditional method used by the industry to remove the insulation. It has been the most convenient and least expensive method available. However, combustion is not complete when this material is burned, and so a soot forms. The gaseous pollutants created by this method lessens its attractiveness.

Use of organic solvents has been proposed, but it is difficult to find a universal solvent for the different types of insulation. Mechanical, methods such as stripping, chopping, grinding, or hot pressing does not pollute the air as much as burning and it also produces a cleaner product. These procedures, though, are more expensive than burning, and they become more and more ineffective if the conductor is part of a complex electronic system. Incinerators which include suitable fume collection, afterburning and gas scrubbing equipment have been developed but these are quite expensive. Because of the increased costs of stripping copper wire, whether done by mechanical methods or by more sophisticated burning equipment, a drop may be seen in the amount of electric wire and copper tubing that is recycled.

Electrical appliance uses are widespread and, often, the copper item is only a small fraction of the total product. The scrap processor, at present, has little economic motivation to recover consumer appliances because handling and transportation costs exceeds the scrap value of the product.

Because of their bulk, appliances are not easily incinerated. Some attempts are made for salvage of major appliances by using new shredding techniques developed primarily for recovery of automobile scrap, but, for the most part, the 21 million appliances which are sent to landfills by scrap collectors or other disposers are not recovered.

It is estimated that of the 32 percent of obsolete copper wire and tubing which is not recycled, between 9 and 18 percent of it is in consumer appliances. Since it appears that it is very expensive to recover scrap from this source, a small increase in the price of secodary copper probably would not increase the supply of copper from appliances in any visible way.

The remaining 14 to 23 percent of obsolete electric wire and copper tubing which is not presently being recycled, representing between 66 thousand and 108 thousand tons of scrap annually, may be quite price elastic. Present secondary copper prices exceed or are at least in the same neighborhood as costs for recovery in these other applications of wire and tubing because, unlike appliances, much of the copper from these sources is already being recovered. An increase in the price of secondary copper might make the implementation of the already developed new wire stripping techniques economically feasible and it might encourage quicker development of other anti-pollution techniques. In the construction industry, a rise in the secondary copper price may help to cover the increase costs of semiskilled labor, and the contractor may no longer find it economically prohibitive to recover demolition waste.

Approximately 69 percent of the potentially available obsolete cartridge brass is not now being recycled. This represents almost 78 thousand tons of copper annually, or five percent of the total available obsolete copper scrap. Used for small arms and ammunition artillery shells, cartridge brass is fired mostly at domestic military bases and in battle-fields. During the Viet Nam conflict, the use of cartridge brass increased substantially and much potential scrap from arms was lost forever. However, the quantity of scrap recovered from domestic military bases probably is sensitive to secondary copper price changes. Although the cartridge brass is often spread over many square miles of land, recycling of this material should not be very difficult because it is easily recognizable and quite valuable.

Some 489.4 thousand tons of obsolete copper scrap in the "Other Brass, Cast and Wrought" category that is potentially available is not presently being recycled. This represents a large chunk of the available obsolete scrap supply-approximately 30 percent. There are a myriad of appli-cations for products from the brass mill and brass foundry industries, ranging from hardware to coinage to watches. Therefore it is difficult to pin-point which of these various end-uses of brass products can easily increase their recycling rates. On the basis of prior knowledge alone it is difficult even to guess how responsive supply will be to increases in prices. Econometric estimation of a supply equation for obsolete copper scrap would be especially useful as a means of providing this information.

Magnet wire is used for windings in motors and generators. Many of these motors are fractional horsepower size for household appliances. These contain small amounts of copper individually, but large amounts in aggregate. As has been mentioned, almost all of these appliances end up staying in landfills. Larger motors contain larger amounts of copper, but they consume less in aggregate. Because copper windings are usually surrounded by iron, simple recovery of them is that much more difficult. An estimated 144.5 thousand tons of available magnet wire, accounting for approximately nine percent of the total available obsolete copper scrap, is not presently being recycled. It does not appear that there would be any significant increase in the amount of scrap in this category that would be recycled in response to a marginal increase in the price of secondary copper.

Copper products which are not recovered are either 1) dissipated beyond recovery, 2) disposed of in solid wastes, or 3) scattered throughout the country.

Copper in the "Copper Alloying Additives" category is an example of copper scrap that is dissipated beyond recovery. Although approximately 96.9 thousand tons of this copper, which is used by the steel, chemical, aluminum, and other industries as an alloying additive, are theoretically available for recovery as scrap material, virtually none of it is recovered. In these applications, copper is a minor part of a much larger system. For example, copper used as an alloying element in either aluminum or steel is often present in amounts under one percent. It is simply economically unfeasible to separate copper from the alloy in these instances. Hence, there is little opportunity for increasing teh recovery of copper scrap from this source. In addition, approximately 10,000 tons of copper are emitted in flue dusts from stack emissions annually in the United States. Even with more air pollution controls, this copper will probably continue to be lost simply because the material contains low concentrations of the metal.

Solid waste disposal sites, particularly in urban areas, presently receive as much as 30 to 50 percent of the unrecovered copper products. An estimated 40 million tons of copper have accumulated as urban refuse.

Table 11-3. COMPOSITION OF INPUTS TO INTERMEDIATE CONSUMERS

Scrap type	Percent of total used by consumers			
	Ingot producers & secondary smelters	Brass mills	Foundries and other	Primary producers
No. 1 wire and heavy copper	20.1	19.5	9.7	32.4
No. 2 wire, mixed heavy and light copper	34.5	4.8	19.2	13.8
Copper base	0.5	15.7	58.1	48.6
Low-grade scrap and residues	44.9	0.0	13.0	5.2

Source: Battelle Report, p. 140.

The remaining unrecovered copper is widely dispersed throughout the country, and largely unaccounted for. For example, some of these products are in storage and essentially obsolete. Depending upon scrap prices or innovative collection methods, these products may be recovered as secondary copper.

Copper in disposal sites and copper unidentified as to its whereabouts fails to enter the recovery cycle because of inadequate economic incentives. Improving the economic feasibility of recycling copper in disposal sites is more likely simply because copper is more concentrated at this source.

II. OUTPUTS OF THE SECONDARY COPPER INDUSTRY

The markets for copper scrap are not concentrated. Several different kinds of plants, known as intermediate consumers, purchase unprocessed scrap from industrial plants and partially processed scrap from dealers engaged in scrap recovery. Engaged in one phase or another of secondary copper production are approximately 80 secondary smelters and ingot makers, 50 brass mills, several hundred foundries, and about a dozen primary producers.[4]

The pattern of materials flows among these intermediate consumers is rather comples. Brass mills, foundries and primary producers consume both scrap and virgin copper as inputs so that some substitution of primary for secondary materials occurs within these firms. Secondary smelters and ingot makers consume almost entirely scrap copper. In some cases their outputs, which are made entirely from scrap,compete with the outputs of the other intermediate consumers, which contain virgin copper inputs. In these cases, increases in the relative shares of secondary smelters and ingot makers imply that substitution of scrap for virgin copper is occurring. In other cases the outputs of secondary smelters and ingot makers are used as inputs to other intermediate consumers Where this occurs there is also potential for substitution of scrap for virgin copper.

Historically, brass mills have consumed about 56 percent of the prompt industrial scrap and three percent of the obsolete scrap, or about 35 percent of all copper scrap. Primary producers have purchased about 30 percent of prompt and 35 percent of obsolete scrap, or approximately one third of all copper scrap. Foundries have accounted for approximately three percent of prompt and 12 percent of obsolete, or some six percent of the total. Secondary smelters, ingot producers, and (to a very limited degree) chemical plants account for the remainder.

Almost any kind of copper base scrap can be used to produce copper metal and alloys which are equal in metallurgical quality to outputs of the primary copper industry. Differentials in processing and transport costs have influenced the evolution of various sectors of the copper industry to the extent that certain distinct inputs and outputs have become characteristic of each of the intermediate processors. Table 11-3 shows the consumption of purchased copper scrap by the four main intermediate consumers in the year 1969.

There are two kinds of secondary plants. Ingot fabricators merely remelt alloy scrap and sometimes blend it with primary metal to obtain a specified ingot. Secondary smelters and refiners can remove the impurities from low grade scrap to produce unalloyed refined copper. Secondary smelters use lower grades of metal input than do brass mills and foundries. The output of secondary smelters and ingot fabricators substitutes in some uses for virgin based outputs of the other intermediate consumers.

The brass industry, including mills that produce copper wire, accounts for about 85 percent of total U.S. copper consumption. The metal, in turn, constitutes approximately 90 percent of the raw material inputs to the industry. Slightly less than half of the input of copper to the industry is in the form of high-grade scrap. Nearly all of the scrap consumed by these plants is segregated prompt scrap recycled directly back to the mills as a by-product of metal fabrication. Because the use of obsolete scrap by the brass industry is limited by technological constraints, the opportunities for increasing the flow of scrap to this industry in response to changes in virgin copper prices appear to lie mainly with high-grade prompt scrap. Inasmuch as almost 100 percent of this is already recycled, the brass industry does not offer significant opportunities for greater recycling. Of late, the brass industry has been beset by hard times and many mills owned and operated by primary copper producers have been closed.[5]

Foundries consume alloy ingot produced by secondary smelters. In addition, foundries purchase significant quantities of primary metal and high quality scrap. Castings, which are the principal foundry output, are used in a variety of applications ranging from railroad journal bearings to plumbing valves. The foundry industry has been declining for some time due to substitution by materials such as stainless steel, aluminum, zinc alloys and plastics, and presently accounts for about six percent of copper scrap consumption.

Primary smelters use low grade scrap and residues, including significant quantities of obsolete scrap. Scrap which is high in iron is necessary in matte, an intermediate product in the operations of the primary smelting plant. As refiners, primary producers aim to recover the copper content of scrap, preferring high quality No. 1 and No. 2 copper scrap which are the least expensive to refine.

There appear to be few if any constraints on the amount or quality of copper scrap that can be smelted by primary producers. With proper sorting and processing almost any piece of copper scrap can be used to produce a copper metal that is physically equivalent to the corresponding product made from virgin copper concentrates. Only cost considerations constrain the amount of scrap used by the primary producers, and for that reason we would expect the demand from this source to be quite responsive to market prices.

III. PRIMARY COPPER PRODUCTION

Primary copper is obtained from open pit mines, deep mines, and through the leaching of low grade waste materials. Copper ores are pulverized and then concentrated through differential flotation. Concentrates are smelted to remove sulfur and volatile impurities such as antimony, arsenic, and bismuth. Although copper concentrates are the principal input to the smelters of the primary producers, large quantities of scrap copper are also used as a feed stock. Blister copper produced by these smelters is then refined by fire or electrolysis and cast into refinery shapes and shipped to brass mills, wire mills and other fabricators.

Virgin and scrap copper substitute in several places. The first is where low grade scrap is used along with copper concentrates as an input to primary smelters. Higher grade scrap is processed by secondary smelters to produce an output which subtitutes for blister copper as a refinery input. High grade scrap, much of it obtained as an industrial by-product of manufacturing operations, is melted and fabricated into ingots which can substitute for refined primary copper. Finally, the highest quality prompt scrap substitutes for primary ingots as an input to the brass industry. Much of this latter scrap is captive in that the fabricating operations where it is generated are owned or controlled by the primary producers which also happen to own brass mills. This scrap is automatically recycled regardless of market prices.

IV. MODEL SPECIFICATION

Our narrative description of the copper industry suggests that the industry is conveniently disaggregated into a primary sector, a secondary sector supplying new (prompt) scrap, and a secondary sector supplying old (obsolete) scrap. An annual model of the domestic copper industry, formulated along these lines has been estimated by Fisher et. al.[6] Independent of this work we used monthly data to model a number of the processes where primary and secondary copper substitute for one another. We found it impossible, in general, to specify an identified demand curve, and therefore, were restricted to the estimation of supply equations alone. The estimated supply elasticities using monthly data were somewhat higher than the long-run supply elasticities estimated by Fisher. The probable cause of this disparity is that deviations in prices from their expected value induce fairly large short-run increases in quantity supplied as speculative inventories adjust. In the long run the responses may be more muted. A depletion of the accumulated reservoir of available scrap due to high prices in the present period of would lead, other things equal, to lower collections of scrap in the future. Thus the long run response to a permanent upward shift in price may be considerably less than the short run impact.

Fisher's econometric model of the domestic copper market is especially valuable to us in that it provides estimates of supply and demand elasticities for primary copper, as well as the supply elasticity for secondary copper, all three elasticities being necessary for the evaluation of tax induced shifts in supply curves on market price. Additionally, the Fisher approach can be viewed as providing long-run parameter estimates, a feature which is certainly open to doubt in a monthly model.

The supply of primary copper was modeled by Fisher as a distributed lag over past copper prices. The basic stock adjustment model described in Chapter 10 was used to model the supply of primary copper. U.S. mine production in thousands of metric tons, Q_t, was regressed on the price of copper, P_t, and lagged mine output. Prices were obtained from the Engineering and Mining Journal (computed by the EMJ as .975 times the U.S. producer price plus .025 times the London Metal Exchange price), and then divided by the wholesale price index (1967 = 100) and expressed in dollars per metric ton. The primary supply equation was estimated by two steps least squares with an autoregressive correction for serial correlation.

$$Q_t = -160.04 + \underset{(2.99)}{14.27\,P_t} + \underset{(3.55)}{0.726\,Q_{t-1}} \tag{24}$$

$p = 0.5$ Years: 1949-1958, 1962-1966

The years 1959-1961 and those following 1966 were deleted to eliminate the effects of major copper strikes in 1959 and 1967-1968. Denoting the current period estimated response as the short run and the final equilibrium response as the long-run, short-run supply elasticity is .45 and in the long-run 1.67.

Obsolete and prompt copper scrap are generated by two fundamentally different processes. Because scrap copper statistics report old and new scrap separately, it was feasible to estimate separate supply equations for each sector.

For obsolete scrap the supply equation should reflect the impacts of both availability and price on quantities supplied. Availability equals cumulative production plus net imports, less removals for recycling and natural decay of the material over time. Fisher estimated a cumulative availability series, which he termed K_t^*, by assuming an initial stock of material available for recycling in 1948 and adjusting this stock each year to reflect production, net imports and removals for recycling. Several different values of the 1948 stock were used, but the choice of this variable had almost no impact on the estimated coefficients in the supply equation. The price for scrap copper was taken to be the London Metal Exchange price. There is a separate domestic scrap copper price; it is highly correlated with the LME price and yielded substantially the same results as those reported below. Denoting the quantity of old scrap recycled in year t in thousands of metric tons by OS_t, and the price deflated by the wholesale price index by P_t, the estimated obsolete supply was:

$$\log \frac{OS_t}{60{,}000 + K_t^*} = -9.878 - .3731 \log \frac{OS_{t-1}}{60{,}000 + K_t^*} + .422 \log P_t \tag{25}$$

$$\qquad\qquad (2.96) \qquad\qquad (3.99)$$

$\rho = 0.9$ Years: 1950-1968

The implied short-run elasticity of old scrap supply with respect to the LME price is about .43. The long-run elasticity of .32 is lower because high collections in one period reduce the quantities available for recycling in subsequent periods.

The model for new scrap production was estimated as a linear function of total copper consumption. Denoting new scrap collections in thousands of metric tons by NS_t and total consumption, also in thousands of metric tons, by C_t, the estimated supply of new scrap was:

$$NS_t = -275.2 + \underset{(7.56)}{0.3961}\, C_t \tag{26}$$

$\rho = 0.2$ Years: 1947-1968

There was no evidence of a significant price effect on new scrap supplies.

The demand for copper was specified as a distributed lag over the EMJ price of copper, P_t, the lagged price of the substitute aluminum, ALP_{t-1}, the 'Federal Reserve Index of industrial production, IP_t, and the change in inventories of consumer durables, ID_t. The estimated equation was:

$$C_t = -14.75 - \underset{(7.06)}{12.37}\, P_t + \underset{(1.79)}{8.29}\, AIP_{t-1} + \underset{(5.56)}{5.08}\, IP_t + \underset{(9.43)}{60.49}\, ID_t$$

$$-\underset{(6.25)}{44.40}\, ID_{t-1} + \underset{(7.02)}{0.79}\, C_{t-1} \tag{27}$$

$\rho = -0.8$ Years: 1950-1958, 1962-1966

At the means the short-run elasticity of copper consumption with respect to the price of copper is -. 173 and the long-run elasticity if -.867.

The final equation which is necessary to close the model is the relationship describing net exports of copper from the rest of the world into the United States. Let X_t denote exports in thousands of metric tons, $LMEP_t$ the London Metal Exchange price, PP_t the domestic producer price of copper, C_t the domestic consumption of copper, Q_t mine production, and D_t a dummy for the presence or absence of export controls. The estimated net export equation was:

$$X_t = -795.5 + \underset{(2.21)}{1.397}(PP_t - LMEP_t) + \underset{(2.20)}{0.934}(C_t - Q_t) + \underset{(2.64)}{145.8}\, D_t \qquad (28)$$

$$p = -0.1 \qquad \text{Years: } 1952\text{–}1968$$

An increase in the U.S. producer price of one cent per pound with the LME price constant increases net exports by about 31 thousand metric tons. No elasticity was reported by Fisher.

V. EVALUATION OF TAX IMPACTS

In this section we use the econometric model to estimate the impact of virgin material tax preferences on incentives to recycle scrap copper products. The estimates assume the virgin copper supply curve is shifted by the full amount of the tax, that is that all taxes and subsidies are passed forward into product prices.

A five percent increase in the supply price for domestic mine production, which is about the maximum one could expect if all tax subsidies to primary producers were eliminated (see this report, p. 104), would induce increased imports into the U.S., increase old scrap collections, and reduce both the quantity of copper consumed and domestic mine production. We will compute each of these in turn,

The long-run response of mine production to a one cent per pound increase in the price of copper is about 280 thousand metric tons, whereas net imports would increase by some 31 thousand metric tons. Although imports do respond to price differentials between the London price and the domestic producer's price, the impact is small relative to the impact on mine output. Furthermore, the fact that Fisher did not present the elasticity for net imports complicates the calculation of the final equilibrium. We will ignore imports in the computation below, but it should be noted that if imports were included the estimated price impact would be diminished and the quantities of old scrap recycled would be less than those estimated in this section.

The long-run price elasticity of domestic supplies (the weighted average of elasticities of mine production, 1.67, and obsolete scrap collections, 0.32 with eights of 0.45 and 0.185 respectively--new scrap and imports accounting for remaining fraction) is about 0.81. The supply curve for final copper outputs is shifted upward by 5 percent times the share of primary copper in total industry supply (0.45), or about 2.25 percent. The equilibrium price of copper rises by a percentage equal to the amount of the supply shift multiplied by the ratio of industry supply elasticity to the sum of supply and demand elasticities, or $\Delta P/P$ = 2.25 percent X 0.81/(0.876 + 0.81) = 1.08 percent. The consumption of obsolete scrap copper would rise by the product of this price change and the scrap supply elasticity, or 0.32 X 1.08 = 0.35 percent.

CHAPTER 11

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CHAPTER 12

ALUMINUM

Aluminum ranks second by weight to steel in domestic metal output. The supply of aluminum for domestic consumption is derived from domestic bauxite production, imported bauxite ores, imports of alumina and aluminum, and recycling of scrap aluminum. In 1968 these supplies in thousands of short tons were: domestic production 418, imports of bauxite 2,748, imports of alumina 696, imports of metal 785, and secondary metal 817[1]. Exports amounted to some 808 thousand short tons of metal.

Two features distinguish aluminum from the other metals in this report. The first is the relatively small impact of percent depletion and other subsidies on the market price. As discussed in Chapter 6, percent of depletion is available on the value of bauxite produced, but bauxite costs are a small portion of the total cost of producing aluminum. The second feature distinguishing aluminum from the other metals in this study is the low percentage of obsolete aluminum that is presently recovered. In contrast to lead where obsolete scrap accounts for over four-fifths of total scrap supplied, and copper where obsolete scrap is more than one-third of total scrap supply, obsolete aluminum accounts for only about one-fifth of the aluminum scrap supply. In part this is a reflection of the relatively young age of the aluminum industry and the consequent small stock of metal available for recycling, but it also reflects a basic technological constraint that prevents recycled aluminum from attaining as high a purity as primary metal made from bauxite ores.

This chapter is divided into five components.

1) Inputs to the secondary aluminum industry
2) Outputs of the secondary aluminum industry

3) Outputs of the primary aluminum industry
4) Discussion of model specification and estimation
5) Evaluation of tax impacts

I. INPUTS TO THE SECONDARY ALUMINUM INDUSTRY

A, Obsolete Scrap

The transportation industry (principally airframe and automobile recycling) account for well over half of all obsolete aluminum that is recycled. (Battelle)[2] Other important sources include building and construction, consumer durables, electrical and, machinery and equipment. The relative importance of the various sources of aluminum scrap and the percentages of scrap generated by each source ultimately recycled are shown in Table 12-1.

Of the various sources of old scrap the automobile should contribute most to future growth in scrap availability. At present the automobile accounts for about 40 percent of the scrap originating in the transportation sector or about 25 percent of all obsolete scrap which is recycled. In the 1950's and early 1960's the typical automobile contained some 30 to 40 pounds of aluminum, but recently the use of aluminum in automobiles has increased to a range of 70 to 90 pounds. In the future as these cars are scrapped the supply of old aluminum available for recycling will be augmented substantially.

B. Prompt (New) Scrap

The aluminum industry itself and other industries that fabricate aluminum products are the principal sources of new scrap. Fabricating activities which generate the largest quantities of prompt scrap include the production of airframes, aircraft engines, automobiles, metal stampings, doors, windows, trim, and refrigeration machinery.

II. OUTPUTS OF THE SECONDARY ALUMINUM INDUSTRY

Secondary aluminum smelters are the largest intermediate consumers of aluminum scrap, purchasing approximately 70 percent of the total annual supply. (Gordon)[3] Their major product is secondary aluminum alloy ingots, made almost entirely from scrap. Most of these alloys are sold to the casting industry.

Table 12-1. OLD ALUMINUM SCRAP RECYCLING, 1969

Scrap source	Estimated aluminum becoming obsolete, tons	Estimated old aluminum recycled, tons	Estimated percent recycled	Estimated aluminum not recycled, tons
Building and construction	71,000	9,000	13.0	62,000
Transportation	329,000	100,000	30.0	229,000
Consumer durables	197,000	25,000	13.0	172,000
Electrical	7,000	6,500	93.0	500
Machinery and equipment	61,000	15,000	25.0	46,000
Containers and packaging	486,000	2,000	0.4	484,000
Other	183,000	17,500	9.2	165,500
Totals	1,334,000	175,000*	13.1	1,159,000

* Imports are ignored because it is believed that the old scrap component of imports is not significant.

Source: U.S. Bureau of Mines, Minerals Yearbook, 1969, Preprint for Aluminum, and Appendix B, Table B-1.

The casting process uses molten aluminum and is more tolerant of foreign metal contamination than either the milling or extrusion processes. Because of this, secondary smelters purchase all grades of scrap, including most of the supply of obsolete scrap. About 85 percent of the obsolete scrap that is recovered each year is consumed by secondary smelters, this source of supply accounting for about 15 percent of their inputs.

Nonintegrated fabricators can act as intermediate consumers or final consumers. As intermediate consumers they purchase about 18 percent of the total scrap supply. Nonintegrated fabricators are aluminum fabricators that do not have primary aluminum reduction capabilities. Because they must obtain all of their aluminum requirements from outside sources, the availability of scrap is important to them. Secondary aluminum use is possible for nonintegrated fabricators because many of them specialize in extrusion processes which are intermediate between casting and milling processes in tolerance for secondary alloying metals. Still this scrap must be of the highest quality, and as a result, virtually all of the secondary aluminum purchased by this sector is prompt industrial scrap.

Primary producers consume the remaining 12 percent of the scrap supply, a small percentage of which is obsolete scrap.

Ultimate consumers of secondary aluminum include rolling mills, nonintegrated fabricators specializing in extrusion processes, foundries, and plants which manufacture aluminum products for deoxidizing steel and other chemical processes.

Rolling mills are dependent on primary aluminum ingot as an input. The rolling mill process requires that cold aluminum be squeezed by rollers producing items such as sheet, plate, and pipe. To provide suitable-feedstock for rolling mills the cold aluminum ingot must be high in purity and contain very low percentages of alloying agents. Because it is difficult and economically infeasible to remove metallic contaminants and alloy constituents from aluminum scrap by the usual melting and refining processes, only small quantities of the most pure secondary aluminum go to rolling mills.

For the most part, extrusions require the use of the more pure primary ingots. This market can tolerate the use of some secondary alloy ingots, but they must be made from the most select, clean scrap. The use of obsolete scrap by this sector is almost nil.

Foundries produce casting alloys which are used in die, permanent mold, and sand casting. The specifications for many of the casting alloys permit more than trace amounts of iron, zinc, and manganese. This, then, is the major market for secondary alloy ingot produced by secondary smelters. Many of the castings are prepared from obsolete and prompt scrap that has not been highly segregated.

Although two ingot alloys prepared to specification for consumption by the foundries by either a primary producer or a secondary smelter are completely substitutable, alloy ingots produced by secondary smelters usually are purchased because they are less expensive. Primary producers have been competing in the castings alloy market since 1950 by selling molten aluminum to major customers such as automobile manufacturers at special prices under long term contracts. The automobile manufacturers cast the molten aluminum into the necessary parts at their own plants. The discount offered by the primary producers for this form of delivery ranged up to 15 percent of the list price of 99.37 percent pure aluminum. In an industry where there is typically about a three cent difference in price between primary and scrap aluminum, this discounting garnered a substantial share of the castings market for primary producers. Apparently, despite hearings in the late 1950's by the House of Representatives' Small Business Committee, there has been no action to prohibit these contracts. Recently, large secondary smelters have entered the molten aluminum market, further intensifying competition between primary and secondary metal, but also returning secondary aluminum to the position of dominance it once held.

The importance of the castings industry to the producers of secondary aluminum suggests that, the future of aluminum recycling may be closely tied to the future performance of the castings industry. Of 1969 castings shipments, die castings accounted for 60.5 percent, permanent mold castings represented 25.6 percent, and sand castings made up 13.0 percent. The major die castings market is the automobile industry. The correlation between swings in automobile production and the production of secondary aluminum derived from obsolete scrap appears to be high, judging by casual inspection of the two series. The amount of obsolete scrap that will be recycled may be constrained by the performance of the castings industry, particularly the market for automotive castings.

Plants which manufacture deoxidizing chemicals consume about 50,000 tons of aluminum annually. Low purity aluminum can be used for the production of these chemicals. Secondary smelters presently have approximately 60 percent of this market. Although this is an area of open competition between primary and secondary aluminum, the market is too small to contribute significantly to the demand for obsolete scrap. The same is true of the demand for other products using aluminum, such as aluminum chloride, pyrotechnics, explosives, and exothermics.

III. MODEL SPECIFICATION AND ESTIMATION

This section reviews the system of linkages between shifts in virgin material supply curves and the use of scrap materials. The key relationships are then estimated through the statistical analysis of time series data.

A change in the tax status of inputs to the primary aluminum industry first induces a shift in the industry supply curve. The shift in supply translates into a change in the equilibrium price of primary aluminum at all stages in its manufacture. Certain of the intermediate and final products of the primary aluminum industry compete with the corresponding products of the secondary aluminum industry as inputs to other production processes and as items of final consumption. These points of substitution must be identified and the impact of changes in the price of primary-based products on the use of secondary aluminum outputs must be estimated.

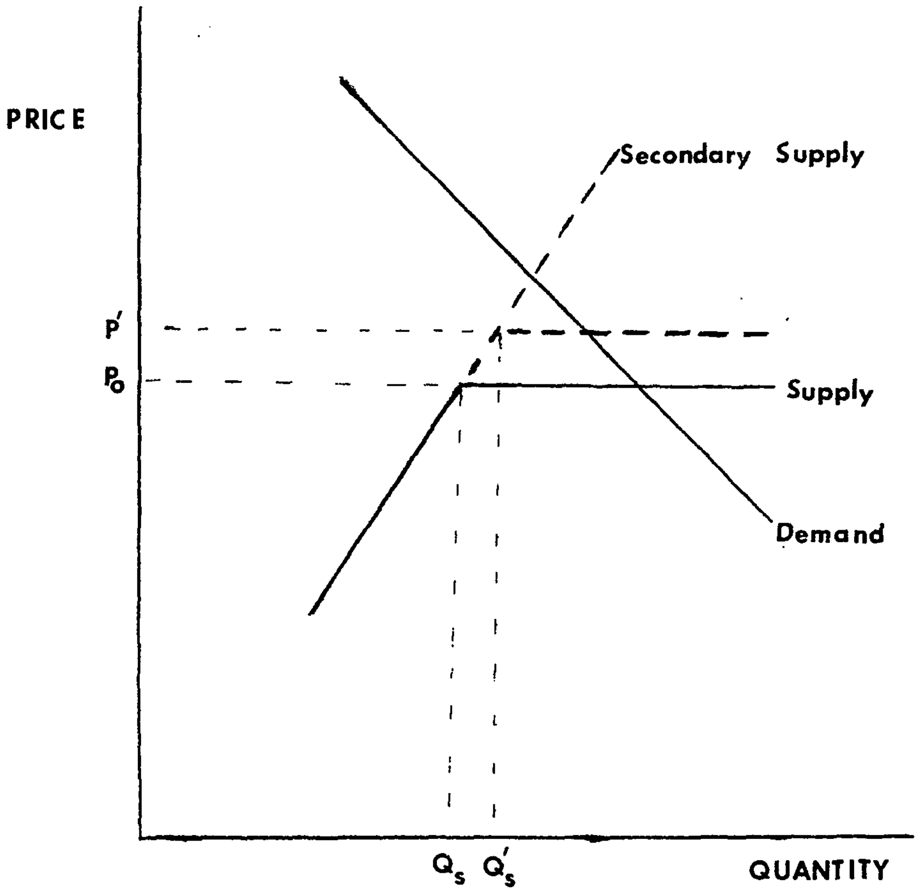
The relative abundance of high-grade bauxite deposits in the earth's crust suggests that the long-run supply curve of primary aluminum is probably highly elastic. In fact when Charles River Associates[4] modeled primary aluminum supply they explained price in terms of production costs, implicitly assuming the own price elasticity of supply was infinite. Under this assumption the demand elasticity for all aluminum outputs is irrelevant for purposes of computing price effects of tax subsidies. An increase in the cost of producing primary aluminum, attributable to the elimination of subsidies such as percent depletion, would increase the long-run primary aluminum price per pound by approximately the amount of the subsidy per pound produced. The approximation that market prices increase by the amount of the shift in supply overstates the change in market price to the extent supply is less than infinitely elastic. The amount of the overstatement could be quite large in view of the elastic nature of primary aluminum demand (estimated at -3.35 by Charles River Associates, p. 6-66). If the supply elasticity was +3.35 rather than infinite, the impact on price of a unit shift in supply would be halved.

Industries which use both secondary and primary aluminum as inputs may be viewed as facing a kinked supply curve for inputs. Below the market price of primary aluminum they face the supply curve of secondary aluminum. The input supply curve becomes elastic at the market price of primary aluminum. This suggests that the input demand curve intersects the supply curve to the right of the kink at Po. (See Figure 12-1)

Should the market price of primary aluminum rise the new input supply curve would follow the supply of secondary aluminum up to the new equilibrium

FIGURE 12 - 1

INPUTS TO CASTINGS AND EXTRUSION INDUSTRIES



price of primary aluminum and become elastic at that point. The quantity of secondary aluminum consumed would rise from Qs to Qs' subject to the constraint that Qs' not exceed demand at P'. We will not attempt to estimate the demand curve for inputs to the castings, extrusion, and chemical industries which process aluminum into final products, but rather assume that this constraint is not binding given that the change from Qs to Qs' represents a small (less than 10 percent) increase in secondary use relative to the quantity of primary aluminum used in each of these industries. The constraint would be binding only if the demand curve was highly elastic.

The elasticity of the supply curve for secondary aluminum is the one remaining unknown required to estimate the impact of tax subsidies to primary producers on the quantity of scrap recycled in the model we have just outlined. We will assume that as the production of castings and the like varies over time the demand for primary and secondary aluminum inputs fluctuates about a relatively fixed supply curve. The points of equilibrium between demand and supply will trace out the supply curve. Again referring to Figure 12-1, equilibrium pairs such as PO, Qs will be points on the supply curve for secondary aluminum.

We attempted to estimate this supply curve from monthly time series data. Theoretically it should make no difference whether prices for primary or secondary aluminum ingot are used. In equilibrium these two prices should converge. In fact, however published prices are not the same for primary and secondary aluminum. The usual explanation for this is that the quoted price for primary aluminum does not represent the price at which primary ingot is actually traded. Rather the published price serves as a benchmark from which primary producers offer discounts. Conveniently for our purposes the discounted or real transactions price for primary ingot is thought to be accurately represented by the price of secondary aluminum. (CRA) The price used in the supply equation was the price of #12 Secondary Alloy Ingot.

For quantity we used net metallic recovery from aluminum scrap and sweated pig consumed at secondary smelters. This quantity includes 100 percent of aluminum recovered from old scrap plus a small percentage of recovery from new scrap. Most new scrap is consumed in the primary sector with only small amounts consumed at secondary smelters.

The supply equation was estimated by two stage least squares using as instruments lagged price, lagged quantity, and the Federal Reserve Index of automobile production. Secondary supply was estimated as:

$$Q_t = 5.8 + \underset{(1.42)}{1.44P_t}$$

Years: 1962-1972

Although price has the correct sign in the supply equation, it is marginally significant as best. Consequently, the estimated short-run price elasticity of .86 must be interpreted with caution. Because the elasticity exceeds that found for the long-run supply of scrap copper and scrap lead, we are inclined to believe the estimate for aluminum errs on the high side.

In Chapter 6 it was predicted that.elimination of percent depletion for aluminum would elicit at most a two percent increase in the price of primary aluminum. According to our estimate of the secondary supply elasticity such a price change would increase the quantity of aluminum recycled by 2% x 0.86 = 1.7%.

CHAPTER 12

REFERENCES

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CHAPTER 13
SUMMARY

This report consisted of two major sections: the first in Chapters 2 through 6 contained an analysis of governmental tax policies and how they affect the supply of virgin raw materials; the second in Chapters 7 though 12 analyzed the impact of tax policies on the recycling of various materials. We met with varying levels of success in completing the two segments of the project.

Estimates of the impacts of tax subsidies on material supply can be based on a rigorous theoretical foundation. For the depletion allowance, which may be viewed as a negative excise tax on output, supply is shifted by the amount of the subsidy. Preferential taxation of capital gains probably should be viewed as a subsidy to capital as a factor of production. To estimate the shift in supply resulting from the preferential taxation of a single factor would require knowledge of the elasticity of substitution in production and the supply elasticities for inputs. These parameters are not well known for the timber industry. In this situation we used the combination of assumptions which would yield the maximum impact on supply. Consequently, the figures for the timber industry may overestimate the long-run impact of capital gains taxation on timber supply. Tabulated below are the upper limits effects of tax subsidies on the supply curve for five virgin materials.

Similar estimates were made in a 1974 study conducted by Booz, Allen and Hamilton.[1] In that study the impacts on virgin material supply curves were interpreted as price impacts. This interpretation would be valid only in the case where virgin material supply curves are infinitely elastic. The available evidence on this subject (see the sections on lead and copper for examples) does not support this assumption; supply curves appear to have an elasticity between one and two. This indicates that the price impacts computed in the Booz, Allen and Hamilton report are overstated by a factor of about two.

Table 13-1. IMPACTS OF TAX SUBSIDIES ON VIRGIN MATERIAL SUPPLY CURVES

	Maximum possible impact	Likely impact
Steel	3.0%	2.0%
Paper	4.2%	1.0%
Lead	3.0%	
Copper	6.0%	5.0%
Aluminum	2.2%	

Both the Booz, Allen and Hamilton report and the present study tried to assess the impacts of virgin material tax subsidies on the flow of recycled materials. As noted in the introduction, the Booz, Allen and Hamilton report relied on interviews with industry executives to assess the impacts of tax subsidies on the flow of recycled materials. This approach met with little success and pointed out the need for the development of econometric models of primary and secondary materials flows.

The present study based the econometric approach on the analysis of primary and secondary material flows. Five pathways were identified where significant substitution of the two materials occurs. An econometric model of supply and demand was specified and estimated for the pathway of most extensive substitution in each industry. The following paragraphs develop a general model of scrap markets with special reference to the wastepaper and scrap steel industries.

For both wastepaper and scrap steel the most significant substitution of secondary for primary materials occurs in the primary processing sectors. This suggests that important determinants of demand include (1) A, the level of activity in the manufacturing industries which consume scrap inputs, (2) P, the price of secondary materials, (3) V, the price of competing virgin-based inputs, and (4) T, the technology of material processing. Representing the quantity demanded in period t by Q_t, we have:

$$Q_t = a + bA_t + cP_t + dV_t + fT_t + e_t \tag{1}$$

where e is a random variable with mean zero.

Reported quantity data include two components of supply: prompy scrap and post-consumer scrap. The supply of prompt scrap is easily represented as a function of current or recent levels of activity in primary manufacturing operation, but the supply of post-consumer scrap is far more difficult to model adequately. We assumed that X_t, the supply of obsolete scrap in period t, is a function of the price of scrap, P_t, and the availability of scrap material, K_t, and the technology of scrap recovery R_t. That is:

$$X_t = g + jP_t + jK_t + kR_t + v_t \tag{2}$$

The linear additive form for this relationship was based on the assumption that within the range covered by the data, the effect of price on quantity is approximately independent of the availability of scrap or the technology of scrap recovery. We did not expect this assumption to hold precisely, but it facilitates estimation of a supply equation from existing data. By availability is meant the relative ease with which additional units of scrap can be recovered from the environment. This depends upon the absolute size of the reservoir of post-consumer scrap as well as the extent to which the readily recoverable scrap has been retrieved in recent periods. More formally, availability may be approximated as:

$$K_t = mP_{t-j}Y_t \tag{3}$$

where Y is the stock of consumer and capital goods containing the material of interst, and lagged price, P_{t-j}, reflects the extent of previous scavanging efforts. The higher was price j periods ago, the lower is availability today.

Changes in the stock of material from which obsolete scrap is derived in turn depend upon the output of final consumption goods made of the material, the removal of obsolete scrap from this reservoir, and the physical decay of the stock (e.g., rusting). Therefore:

$$Y_t = A_t - X_t - \lambda Y_{t-1} \tag{4}$$

where all variables are as defined previously and λ is the rate of physical decay.

The final supply equation is obtained by combining (2) and (3) and adding a prompt supply component, A_{t-i}.

$$Q_t = g + hP_t + rP_{t-j}Y_t + kR_t + nA_{t-i} + v_t \tag{5}$$

Data on Y_t, are not reported. In principle, such a series could be generated from existing series and the posited relationship in (4). In practice, we were unable to obtain satisfactory measures of the rate of decay and resorted to the assumption that the stock was constant over the period covered by the data (approximately 12 years for both paper and steel). The final specification of demand is (1) and of supply is (5) with the multiplicative term Y_t dropped.

At least two considerations remained before we were able to proceed with statistical estimation of demand and supply. One consideration was the frequency of observation, in particular whether to use monthly or annual data. The second consideration concerned data reliability and this was discussed at length in the report.

Reviewing demand (1) and supply (5) one notes that lagged values of many or the determinants of demand are also determinants of supply (e.g. price and primary processing activity). Discussions with industry representatives and a brief review of the trade literature suggested that the lag in both cases is fairly short - on the order of a few months at most. If the equations are estimated with annual data one must choose some linear combination of current and one-year-lagged values of price and industrial activity for the supply equation. Because current price already appears in the supply equation, this procedure will certainly introduce multicollinearity to supply. Furthermore, the fact that so many of the same variables appear in both the supply and demand equations introduces the risk that neither equation will be identified - particularly if technology cannot be accurately measured and virgin and input prices are unreliable as indicators of true input costs. This suggests that identification of the equations and estimation of separate parameters would be more likely to succeed with monthly observation intervals. Also, we might add, many of the reported quantity series were consistent for relatively short periods. However difficult this factor makes the compilation of reliable monthly time series, it renders nearly impossible the construction of consistent annual data series of reasonable length for many variables. Again we conclude that monthly data are more appropriate.

The frequency of the data intervals bears no necessary connection to the interpretation of parameters in the equations as short-run or long-run. For example, cross sectional relationships are frequently interpreted as long-run, even though all observations occur at one point in time. In comparing monthly with annual models the designation short-run would best be applied to the model which is designed to capture equilibrium relationships. Typically, long-run models use distributed lags to capture the ultimate impacts of changes in the independent variables. The models used in this study were not designed to capture all long-run impacts (e.g. investment effects), but do represent our efforts to measure equilibrium responses as constrained by existing plant and technology.

Accuracy of price data is another problem confronting those who would develop econometric models of secondary material markets. Secondary material prices are assumed to be generated in competitive markets and to be reported without bias. However, the accuracy of the published prices of virgin materials which substitute for scrap steel and wastepaper was questioned in the separate chapters on each product. These prices are posted by oligopolistic industries and may not represent actual transaction prices. Furthermore, because less then 10 percent of the product is actually sold, the remainder being consumed internally by vertically integrated producers, the price may bear little or no relationship to the costs of production. These measurement errors have important implications for the estimated demand equations because measurement errors in variables will bias regression coefficients toward zero.

The fact that the cross elasticity of demand for scrap with respect to the price of the competing virgin based input is biased toward zero in this specification dictates that we consider alternative demand specifications that do not have this bias. One such possibility is to assume that secondary and primary inputs are perfect substitutes and that the quantity of secondary material purchased is small enough relative to total demands that the own price elasticity may be taken as infinite (as in Figure 12-1). A second such alternative is to assume an infinite cross elasticity and estimate the combined input demand curve (as in Figure 10-1). The first approach may be appropriate for aluminum and paper, where about one-fifth of all inputs are derived from secondary materials, but it clearly would not hold for lead or scrap steel, where half of the metallic inputs come from secondary sources. The second alternative appears especially appropriate for lead, copper, and to a lesser extent, steel, where outputs of the primary and secondary sectors are virtually indistinguishable and substitute freely in a wide variety of industrial applications.
Table 13-2 contains a summary of the estimated impacts of virgin material tax subsidies on the quantity of secondary materials recycled. All figures are based on maximum price effects from Table 13-1, and are expressed as a percentage of the quantity of secondary materials currently recycled.

Table 13-2
RECYCLING IMPACTS OF TAX SUBSIDIES TO VIRGIN PRODUCERS
UNDER ALTERNATIVE DEMAND SPECIFICATIONS

Secondary material	Demand dependent on virgin and scrap prices	Demand elastic w.r.t. all prices	Combined input demand curve estimated
Scrap steel	0.37%*		
Wastepaper	0.04%	0.67%	
Lead			0.09%
Copper			0.61%
Aluminum		1.7%	

* The impact on obsolete scrap may be twice this large - if prompt scrap supply is independent of price.

Although the indicated near-term impacts of tax subsidies to virgin material industries are modest, these subsidies distort long-term investment decisions toward that sector. As noted in Chapter 6 these investment decisions lower the total output of goods and services produced in the economy. The relatively low recycling responses which could be expected to follow the elimination of virgin material tax subsidies could be attributable, in part, to the investment distorting impacts of the subsidies (e.g. locating paper plants near pulp wood supplies).

Tax subsidies to virgin material production. are only one aspect of existing federal policies which adversely affect the flow of recycled materials. As noted in the introduction, these other policies include freight rate discrimination, labeling requirements for scrap-based products, mining laws which give away valuable mining rights, a failure to price residential solid waste disposal, and in other ways pricing materials at less than their full social cost. Although the impacts of virgin material tax subsidies appear to be modest (within existing technologies and capital stock), the cumulative long-run impact of all federal policies which affect material use may be to reduce significantly the flow of recycled materials.

The use of these econometric models of materials flows is not limited to the analysis of virgin material tax subsidies. Also within the realm of analysis are tax subsidies to producers and consumers of secondary materials as proposed in H.R. 148 and H.R. 9467. The impacts of other market parameters can be assessed to the extent they can be translated into price changes. For example, the impact of differential freight rates on recycling is easy to measure once the differentials have been estimated.

An alternative federal recycling policy which has received increasing attention in Congress,is the direct subsidization of secondary suppliers or users. Under S. 148, for example, suppliers of scrap iron and steel would be granted a 15 percent depletion deduction and those supplying wastepaper would receive an 18 percent depletion deduction. Assuming corporate income taxation at a 48 percent rate and a profit margin of at least the same percentage as the depletion deductions, the price at which scrap steel could be sold would be lowered by 0.48 x 0.15 = 7.2% and that for wastepaper by 8.6 percent. Using the demand and supply elasticities estimated previously, the impact on the quantity of steel recycled would be 2.9 percent and for paper 0.69 percent.

The cost to the government in terms of lost tax revenues should also be calculated if one is to evaluate the merits of depletion deductions to scrap processors. The depletion deduction would apply to every unit of scrap recovered. Its total magnitude may be calculated as: tax rate times the lesser of profit rates or depletion rates times price times quantity.

The impact on quantity is as stated above (reduced by the percentage by which profit rates fall short of allowed depletion rates). For scrap iron and steel the cost per incremental unit recovered would be (7.2)/2.9 = 2.5 times market price, and for wastepaper the cost per additional unit recovered would be (8.6)/(0.69) = 12.5 times current market price. One could question whether the social costs of unrecovered scrap exceed the private costs of this scrap by a multiple of several times market value. If social costs fail to exceed private costs by this margin there is no economic justification for this piece of legislation.

Another form of tax subsidies is a direct cash payment to scrap users. The $10 per ton credit to users of wastepaper contained in H.R. 9467 would shift demand upward by the amount of the subsidy. Using the parameters of the wastepaper model estimated in this paper it can be shown that quantity would increase by 2.4 percent. The cost to the Treasury would amount to 12.5 times the assumed market price of $30 per ton. Again one must assume very large social costs from unrecovered wastepaper to justify such a subsidy.

Several improvements in and extensions to this work can be suggested. First,more effort could be devoted to the analysis of the elasticities of substitution and input supply for virgin material production so that the exact impact of tax subsidies could be derived. A second area of further inquiry would be the completion of some of the econometric models, particularly that of wastepaper, steel, and auminum. For wastepaper, an equation explaining the inventory behavior of scrap dealers would be useful in understanding supply response and market fluctuations. For scrap steel, both an inventory equation and an export equation would be desirable additions to the model. In the case of aluminum a demand equation for secondary metal would be desirable. For steel, wastepaper, and aluminum it would also be useful to attempt to estimate a combined input demand curve, under the assumption that primary and secondary inputs are perfect substitutes in the long-run. A final suggestion for further research concerns the impact of tax subsidies on investment decisions. Clearly, this is an important question. It is our feeling, however, that both the state of the economic theory of investment and the data which are available may be inadequate foundations for such a study at this time.

CHAPTER 13

REFERENCE

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APPENDIX

MINERAL DEPLETION ALLOWANCES

Section 613 of the Internal Revenue Code specifies percentages of "gross income" allowable as a deduction to a maximum of 50% of a taxpayer's "taxable income from mineral producing property". Percentages ranging from 5% to 22% are listed for every mineral but "soil, sod, dirt, turf, water, mosses, or minerals from sea water, the air, or similar inexhaustible sources." Each of the quoted phrases has a significant legal history and will be discussed below. However, the basic concept behind the depletion deduction is rather simple:

> "The statutory concept of taxable income, developed since the adoption of the Sixteenth Amendment, involves the allowance of some deduction based on the theory that production of income may necessitate exhaustion of capital assets employed in that production...The purpose of the depletion deduction is to permit the owner of a capital interest in mineral in place to make a tax-free recovery of that depleting capital asset."[1]

LEGISLATIVE HISTORY

While the theory behind depletion is simple, its actual development has been complex. Despite repeated attacks, depletion provisions were routinely broadened in scope until 1969. The Treasury Department calculated that the excess of percentage over cost depletion* provided a net benefit to mineral industries of almost a billion dollars in 1971.[2] When first enacted in 1926, percentage depletion was much less significant; the mineral industry was much smaller and corporate taxes took 13.75 cents per dollar of corporate

*"Cost depletion" is based upon the actual cost of a deposit to the taxpayer and is similar to the depreciation allowed other industries. Under this method, the taxpayer can usually not deduct more than the actual amount spent on a capital investment, whereas percentage depletion is based on a percentage of gross income and often greatly exceeds actual expenditures. This excess of deductions over expenditures is often the focus of criticism by opponents of depletion allowances.[3]

profits instead of 48 cents. But while our economy has changed, the justification for allowing specific rates of percentage depletion has never been subjected to thorough Congressional analysis.

The first corporate tax, passed in 1909, made no provision for depletion. The Treasury Department developed regulations for it but never put them into effect. The 1913 Act, passed after the 16th Amendment eliminated constitutional barriers to income taxes, included some recognition of the wasting nature of mineral reserves. Taxpayers were allowed to deduct:

> "...a reasonable allowance for the exhaustion, wear and tear of property arising out of its use or employment in the business, not to exceed, in the case of mines, 5 per centum of the gross value at the mine of the output for the year for which the computation is made."

This allowance has been described as "essentially a cost depletion type of calculation,"[4] but more than simple cost depreciation was possible since "gross value at the mine" was interpreted to mean market value as reflected by actual sales. (Merten's,[1] pp. 13-14) In practice, deductions may have been limited to actual capital investment. (The author was unable to discover whether or not the deduction was in fact limited as described. However, given a provision to that effect in the 1916 Act, it seems likely that the 1913 law was equally restrictive. This is Lerner's interpretation - p. 77. See also pp. 24-25.[4])

The 1916 Act introduced use of the term "depletion" and explicitly limited the total allowance to the amount of the capital investment of 1913 value in the case of investments prior to that date. The law specified that the depletion deduction was "not to exceed the market value in the mine of the product thereof, which has been mined and sold during the year for which the return and computation are made...." This provision amounted to a form of accelerated depreciation, since total deductions could be used up well before the mine had ceased to produce. Although not overly generous by today's standards, this provision did come under some attack. One ardent proponent of percentage depletion reportedly called the 1916 law "too generous to be just." (L.C. Gratton, quoted by Lerner,[4] p. 78). However, total deductions could not have been very large since corporate income tax rates were only 2%.

The first major innovation in the tax treatment of minerals came in the Revenue Act of 1918. A new concept was introduced, "discovery depletion", which allowed deductions in excess of actual investment or 1913 value:

> "... in the case of mines. ..not acquired as the result of purchase of a proven tract or lease, where the fair market value of the property is materially disproportionate to the cost, the depletion allowance shall be based upon the fair market value of the property at the date of the discovery, or within thirty days thereafter;"

Under this provision, "discovery value" determined the amount of allowable depletion deductions. Because this change was such a significant departure from past practices, the legislative history will be discussed in some detail.[4 5 6 7]

The bill that emerged from the House Ways and Means Committee would not have made any fundamental changes in the tax treatment of minerals. On the House floor two representatives, Chandler of Oklahoma and White of Ohio, proposed more accelerated depletion as a way of encouraging exploration for minerals. There was some concern expressed regarding incentives for prospecting because of higher wartime tax rates (12% on corporations, 6% to 77% for individuals, and a surtax and excess profits tax were included in the Revenue Act.)

The concept of discovery depletion was introduced in the Senate Finance Committee. According to an Interior Department Study, the star witness before the Committee was Mark Requa, a petroleum engineer with a background in developing statistical methods for estimating oil reserves. "Having considerable confidence in the ability of engineers to estimate reserves, he did not hesitate to assure the Senate Finance Committee that the engineering aspects of evaluating mineral deposits would be a relatively routine matter." (See Lerner[4], page 80.) The Committee apparently had even more faith in the idea than Mr. Requa; he suggested allowing a year for evaluating discovery value, but the bill required valuation within 30 days.

The Committee Report did not specifically explain the reasons for adopting the discovery value approach. The "increased depletion allowance", along with a smaller surtax and excess profits tax on the sale of mines, was justified by the need to "stimulate prospecting and exploration" and in recognition of the "many years and much money" frequently spent "in fruitless search."[6] (page 418) Senator Penrose gave a more detailed explanation on the Senate floor:

> "The committee gave very careful consideration to the question of depletion. ..part of what apparently is income from mines is in reality a mere return of the capital of the enterprise. When, for example, a ton of coal is sold the excess of what is received from the cost of mining of that ton of coal is by no means all income; part of that excess must be treated as a repayment of what was invested in the mine from which the coal was taken.... In pursuance of a policy permitting the development of new resources of this character they also provide for a more liberal allowance than heretofore permitted in the case of newly discovered mines, permitting the deduction to be based on the fair-market value of property discovered instead of its cost."

In addition to providing an incentive for exploration, Congress was also motivated by a desire to accord the same tax benefits to discoveries "aiding the war effort" that were given to pre-1913 mine openings. The 1916 law included a provision exempting value accrued before 1913 from taxation. This was felt necessary to eliminate the unfairness of taxing profits earned but not realized before 1913, when similarly situated persons who had 'cashed in' their investments before 1913 had paid no tax. However, patriotic fervor could not have been a major reason for adopting the discovery method because the war was over and the Armistice signed before the law was passed. (Lerner viewed this historical development as cutting both ways, i.e., as indicating that perhaps the reasons for discovery depletion no longer existed when the bill was finally passed -[p. 8.] Agria[8] emphasizes the "patriotism" factor as an important reason for the bill's passage.)

The change to discovery depletion was not without its critics. Senator LaFollette and Congressman Kitchin, the latter Chairman of the Ways and

Means Committee, both attacked the allowance as unjustified special favoritism.[7]

When discovery depletion was adopted, there was little concern that deductions would be used to offset income from other sources. However, in 1921 the price of minerals declined and deductions based on earlier, higher values were excessive. The Treasury Department suggested that the deduction be limited to 50% of the income from the property. The Senate Finance Committee imposed a limit of 100% instead, with the following explanation:[6] (page 418)

> "...in order to make certain that the depletion deduction when based upon discovery value shall not be permitted to offset or cancel profits derived from a separate and distinct line of business, it is provided that the depletion allowance based on discovery value shall not exceed the net income from the property upon which the discovery is made..."

Three years later the Treasury Department's suggestion was accepted and the limit was reduced to 50%, a provision that was continued under percentage depletion and still exists.

'Percentage depletion was first adopted in the Internal Revenue Act of 1926, but only for the oil and gas industry. Mr. Requa's assurances notwithstanding, by the early 1920's there was growing dissatisfaction with the operation of discovery depletion. A Senate Select Committee on the Investigation of the Bureau of Internal Revenue, chaired by Senator Couzens, was created in 1924. The Committee concentrated on the administration of discovery depletion, a focus probably due to Senator Couzens' suspicion of Secretary of the Treasury Mellon, who had major interests in petroleum and sulfur.

The Committee readily found that the administration of discovery depletion was a disaster. According to Lerner[4], (pp. 83-84)

> "The investigation clearly established that the valuation of mineral deposits, the definition of discovery, and all other facets of discovery depletion were highly arbitrary and extremely difficult to administer. It was brought out

> in the course of the investigation that in the oil and gas industry and in the case of sulfur it had become almost impossible for any oil well not to be deemed a discovery property... the Committee concluded that the Bureau of Internal Revenue had been overly generous in both the assessments of discovery values and in its definition of 'discoveries.'"

Because valuation was so difficult, rulings were being done on an ad hoc basis that favored large operators who could afford expensive legal fees. The Committee even found one case where the same property was evaluated differently for partners holding the same interests. (Lerner[4], p. 33.)

In fairness to the Bureau of Internal Revenue, the administration of discovery depletion was probably an impossible task. Value could not be easily established and provisions for taxpayer appeals sometimes resulted in several years delay when the lawmakers had envisioned a simple 30 day process. Even when done responsibly, valuation naturally aroused great suspicion when poorly understood geological methods were applied to neighboring properties and the outcome was significantly different. Moreover, the methods used depended heavily on subjective judgments of the evaluating engineer, introducing another source of inconsistency. (See Agria[8], pp. 80-81.)

The Couzens Committee, having thoroughly documented the abuses of discovery depletion, urged the adoption of a more easily administered system. The Committee recommended that actual profits be discounted back to the discovery date to determine annual depletion allowances.[8] Selections from the Senate debate (below) indicate Senator Couzens actively opposed any special depletion allowance for minerals. However, the Committee's proposal was not adopted by either the House or Senate.

The House Committee on Ways and Means relied principally on representatives of the Treasury Department in their search for ways to improve the administration of depletion allowances. A.W. Gregg, Solicitor of Internal

Revenue, asked that Congress statutorily define the area encompassed by a well.[9] This proposal was modeled after Treasury Department regulations which created a rebuttable presumption that the range of an oil well discovery was 160 acres; any one claiming another "discovery" within that area had to prove he was not tapping the same reserve. The House accepted this proposal, restricting the availability of depletion as a way of making it easier to administer.

Some strong feelings in favor of eliminating depletion allowances were also expressed during the Ways and Means Committee hearings. Representative Doughton, the Committee Chairman, asked Gregg if the Treasury Department had considered doing away with discovery depletion entirely, indicating his own support for such a proposal. (p. 163)[9]

> "If I had my way I would cut out this discovery depletion entirely. I consider that it might have been justified in time of war, and that the only justification given for it to begin with - for the purpose of inducing men to go ahead and make these discoveries. At the time we put that in, as I recollect it, it was practically admitted that in normal times they would not be entitled to anything of that kind."

Gregg replied that the Department had not gone into the question, having assumed that since Congress had upheld the idea in three acts that the issue would not arise. The same question was asked of Thomas Adams, a professor of political economy at Yale but formerly of the Treasury Department. Adams' response became a standard criticism of depletion allowances:

> "I think a great mistake was made when (discovery depletion) was authorized. I think it is bad in theory and bad in practice. But ...the industry has become habituated to it. It is something like accustoming a child to some debilitating or harmful luxury and not being able to take it away from him all at once. You must legislate in view of the situation that has been created." (Hearings,[9] p. 1006.)

The proposal for percentage depletion came in the Senate Finance Committee. L.C. Manson, who had been counsel to the Couzens Committee, suggested the adoption of percentage depletion for oil and gas wells as a way of eliminating administrative arbitrariness. Starting from the same problems discussed in the House, he reached a totally different conclusion, Since everyone was getting discovery depletion anyway, he argued (Lerner found that "Every oil well, rather than oil wells in new fields, was getting the special discovery depletion allowance.")[4], a flat percentage deduction on all mineral property would be more equitable and much simpler to administer. The Committee agreed and recommended a percentage depletion allowance of 25%.

The source of the 25% figure is unclear. (This conclusion was also reached by Blaise,[6] p. 421.) However, the most likely reason was an intent to duplicate the average allowance taken under the existing discovery provision.[10] This is implied by the absence of any arguments centering on the revenue effects of switching to percentage depletion. Proponents of the change spoke only of its workability. For example, the Senate Committee Report stated, "In the interest of simplicity and certainty in administraton, your committee recommends," a 25% depletion allowance. Senator Reed made a similar statement during the floor debate: "We are trying to get away from those uncertainties and to adopt a rule of thumb which will do approximate justice to both the government and the taxpayers." Several amendments were offered seeking to raise the percentage to as high as 40% but the Senate finally settled on a 30% rate. The figure was reduced to 27½% in conference, an amount that remained in effect until 1969.

Percentage depletion was attacked in the Senate as well as in the House, particularly by Senator Couzens, whose investigation had provoked the change from discovery methods. The nature of the debates indicates that the issues were similar to those made up to the present. In response to a comment by Senator Couzens that cost depletion would be the most easily administered system, Senator Reed replied,

> "It is perfectly obvious that if I buy an acre of land in the Rocky Mountains and pay $10 an acre for it, and then, by hard work, discover a rich deposit of gold on it, the calculation of my depletion on the original $10 basis would not allow me any adequate return for my real capital ...To calculate the depletion on the original cost is not fair either, because in these uncertain industries

> there is much property which is bound to be worthless, on which the taxpayer really makes a dead loss; but there is no production and consequently no depletion from that property."

The same two senators tangled over the issue of the significance of risks in the mineral industries. Senator Couzens argued that "anyone who undertakes an industry, whether it be a manufacturing industry, a bank, or something else, has an element of risk." Reed replied that in other industries "his property is generally worth something, even if the risks go against him. That is not true of the man who takes a worthless mineral claim." Couzens respectfully disagreed.

The debate does not, however, appear to have considered a key question: if discovery depletion allowances were excessive and arbitrarily determined, what sense did it make to set a rate for percentage depletion based on the allowances taken under the discovery provisions? As Lerner explains,(p. 35)[4]

> "It is difficult to see that a system of allowances based upon averaging or aggregation of allowances under the discovery method could result in a more appropriate measure of depletion. The sum of the individual errors and difficulties would not necessarily be a more satisfactory measure than the components. If anything, the types' of 'errors' made in discovery depletion would more likely be cumulative since one 'error' might to some extent be a precedent for another." (See also Agria[8], p. 81.)

One additional result of the Revenue Act of 1926 evolved through regulations issued by the Treasury Department. For purposes of the 50% of net income limitation, the regulations defined "net income" so as to take into account expensed intangible drilling and development costs. This was not true under discovery depletion and in certain cases produced a significant reduction in allowable deductions. (Lerner[4], p. 90.)

EXTENSION OF PERCENTAGE DEPLETION TO METALS

Assuming administrative convenience was the primary motivation for adopting percentage depletion, it seems strange that the switch from discovery methods was at first limited to oil and gas. Two factors may provide at least a partial explanation. First, there is some evidence that oil reserves were particularly difficult to estimate. Senator Reed stated on the Senate floor:

> "We can measure the thickness of the seam of coal, we know its area, and we can calculate with considerable accuracy the tonnage that is in the ground. We do not discover oil in the same way that we discover coal. There is not the element of uncertainty about it [coal]." (Blaise[6], p. 419.)

Second, discovery depletion does not appear to have been nearly as significant for mineral industries as it was for oil and gas. Discovery depletion accounted for over 86% of the depletion taken by the petroleum industry in the early 1920's, but most metal mines were still taking depletion based on 1913 values. Far fewer mines than oil wells were the subject of applications for discovery valuation. (See Lerner[4], pp. 84-89 and Tables in Appendix C.)

However, once percentage depletion became an available alternative, the mining industry was quick to see the potential advantages. For the more commonly found minerals, particularly coal, a depletion allowance based on "discovery" was of little benefit. The process of discovery valuation was also a major expense for small operators and created some uncertainty about expected profits. Miners, too, may have foreseen the potential for depleting expenses other than the value of the mineral at the mine within the phrase "income from the property."

The National Coal Association was one of the first groups to request percentage depletion, asking for a 6% allowance in 1927. The American Mining Congress followed with a request for a 15% allowance for the mining industry. Their representative testified that discovery depletion discriminated against small operators and that percentage depletion of 15% would approximate allowances taken in the past. However, the Mining Congress proposal would have applied only to "discoveries" after the extension of percentage depletion, exhibiting a strange lack of concern for the small miner who had been deprived of depletion allowances in the past.[11] The Mining Congress submitted detailed criticism of the administration of discovery depletion in 1928, raising many of the same arguments made earlier by the petroleum industry. The mining interests had the support of Representative Arentz, who introduced an amendment during committee hearings on the 1928 Revenue Act that would have granted metal mines a depletion allowance of 16½%. Mr. Arentz stated,[12]

> "This amendment is introduced in the interest of simplification of the income tax. ..The outstanding advantages of the amendment are that without materially affecting the public revenue it provides a simple, equitable, and definite method of computing the depletion allowance that permits the prompt and final determination of the tax liability. It eliminates for the future the analytical appraisal of metal mines with attendant technical complexities...I have been informed by the Treasury Department that an investigation of the average depletion percentage allowed was found to be 16% on all returns allowed during the last four or five years."

Discovery depletion continued to be a hot issue and in 1929 the staff of the Joint Committee on Internal Revenue Taxation issued a report on the tax treatment of metal mines.[13] The report criticized the Mining Congress proposals but also found discovery depletion to be neither "simple in its application nor equitable in its results," and urged the adoption of an unspecified "substitute method." The report also discussed the existing record of percentage depletion in the petroleum industry in favorable terms, noting that discovery depletion had resulted in a 53% loss of revenue in 1924, whereas percentage depletion for 1925-26 produced a loss of only 36%. (See Blaise[6], p. 411.)

The staff report also discussed the possibility of extending percentage depletion to mines. A review of the depletion allowances taken on the basis of cost, 1913 value, or discovery value in the period 1922-26 found that the average depletion allowance taken was 17.1% of gross income. The staff recommendation therefore was that if percentage depletion was adopted for metals, the applicable rate be 15%. The reason for the.use of a figure less than past experience may have been to compensate for the higher allowances still being taken under 1913 valuations. L. H. Parker, Chief of the committee staff, came close to endorsing percentage depletion in his letter of transmittal accompanying the report: [14]

> "The methods of percentage depletion proposed for consideration are not such a departure from the present system as would appear from a preliminary inspection. The analytic method of valuation now used in most important cases arrives at the value through the estimation of future expected profits. Depletion based on a percentage of net income from the property merely uses actual figures instead of estimated figures."

A surprising feature of Parker's statement is his reference to calculating depletion as a percentage of net rather than gross income, the latter being the method adopted in 1926. The use of a gross income approach has been criticized for producing inconsistent results depending on the ratio of gross to net income. If the reason for depletion allowances is to encourage investment in mineral industries through higher after-tax profits, then equivalent amounts of net income should receive equivalent tax benefits.

The staff report was followed by Joint Committee hearings in 1930. Mining industry representatives spoke in favor of a depletion allowance of 33%, noting that Canada used that rate, but there was some evidence of internal dissension among corporate officials. (See Lerner[4], pp. 92-3.) A Treasury spokesman, agreed in his testimony that discovery depletion was unworkable but advocated elimination of all depletion allowances rather than adopting percentage methods. (Lerner[4], pp. 93-4.)

However, the precedent had been set and percentage depletion was extended in 1932. Sulfur producers were the first to succeed, arguing that their production processes were similar to oil and that therefore they deserved similar treatment. An amendment in their behalf was added on the House floor. The Senate Finance Committee added a new section reducing the allowance for sulfur to 23% and granting a 15% allowance to metal mines. The coal industry, which was then severely depressed, argued that it needed tax relief just as badly and was given a 5% allowance on the Senate floor. The House acceded to the Senate amendments.

While the adoption of percentage depletion for metals appears to be a significant change in retrospect, the amendments were not a significant part of the revenue act. Congressional response to the depression was the dominant issue and the key provisions were new taxes designed to balance the budget. The committee reports referred to the extension of percentage depletion as "largely administrative", and the amendments were in a section labeled "technical". A comparison of the House and Senate bills included in the conference report indicated that the "revision" in depletion was expected to add $1 million in revenue in fiscal year 1933.

Two other changes in depletion provisions were made as a result of the 1932 Act. The procedures for adjusting the taxpayer's basis in the mineral property were amended to require reduction of the basis by the amount of the deduction taken. Previously, the basis was only reduced by the amount of the deduction that would have been taken under cost depletion. (Lerner[4], p. 34.) The other change was that taxpayers reporting income from mines were required to make a binding election between percentage or cost depletion. Failure to elect meant loss of rights to percentage depletion. This provision was eliminated in 1942. (Lerner[4], pp. 95-96 .)

SUBSEQUENT HEARINGS ON PERCENTAGE DEPLETION

The newly elected Roosevelt administration wasted no time in attacking percentage depletion. A 1933 statement presented to the Ways and Means Committee advocated elimination of depletion allowances:

"Our experience shows that the percentage depletion rates set up in the law do not represent reasonable depletion rates in the case of the designated properties, but are much higher than the true depletion to which the taxpayer is fairly entitled. Moreover, these provisions enable a taxpayer to obtain annual depletion deduction, notwithstanding the fact that he has already recovered the full cost of the property. The deduction is, therefore, a pure subsidy to a special class of taxpayers."

In response, a representative of the Northwest Mining Association criticized the Administration for speaking without adequate experience.

Several years worth of experience later, the position of the Treasury Department was still the same. Secretary of the Treasury Morgenthau denounced percentage depletion as "the most glaring loophole in our present revenue law." (Lerner[4], p. 96)

Similar statements were made by Treasury officials again in hearings on the Revenue Act of 1942. Senators Taft and LaFollette were among those who agreed that "percentage depletion is to a large extent a gift." In spite of this opposition, percentage depletion was extended. Ball and sagger clay, rock asphalt, and flourspar were granted a 15% allowance. Ten additional nonmetallics were granted a 15% allowance in 1943, (flake graphite, vermiculite, potash, beryl, feedspar, mica, talc, barite, lepidolite, and spodumene), but with the understanding that the additions were strictly for the purpose of aiding the war effort and that the legislation would expire with the end of the war. The time limitation was apparently rather hotly debated. Senator Barkley, for example, argued that the disputed minerals would have been added in 1932 if they had been considered. (pp. 98-99)[4] Agria notes that producers took full advantage of the opportunity to emphasize the contribution made by their products to the national defense. "Producers lobbied for every mineral which had any possible connection with the war effort." (Agria[8], p. 82.)

The debate renewed at the war's end. Producers of the disputed minerals argued that if the temporary allowance was permitted to expire they would be the only class of taxpayers in the United States forced to pay higher taxes after the war. They also claimed they deserved percentage depletion just as much as the metal producers. Once again, Congress refused to limit the depletion allowance. In fact, the 1947 legislation extended depletion to bauxite, phosphate rock, trona, and several other minerals.

This period has been characterized as dominated by pork barrel politics; Congressmen faced with the realization that percentage depletion was going to be extended anyway decided that some mineral mined in their district might as well have some too. This development is typified by the following exchange during debate of the Revenue Act of 1942:

> Senator Thomas: "I have conferred with the chairman of the committee and other Senators, and I desire to offer an amendment identical in its provisions with the amendment submitted by the Senator from Tennessee, but including one further term, that is 'rock asphalt.'
>
> Senator McKeller: "I have no objection. I am perfectly willing to modify my amendment so as to include the substitute offered by the Senator from Oklahoma."
>
> Senator LaFollette: "...In my opinion this percentage depletion is one of the worst features of the bill, and now it is being extended. We are vesting interests which will come back to plague us. If we are to include all these things, why do we not put in sand and gravel?"

Sand and gravel were added in 1952.

An extensive list of minerals was proposed for percentage depletion in 1949 and 1950 but legislation was temporarily halted by the need to raise revenue for the Korean War. During that time the Truman administration renewed the attack on depletion allowances. President Truman stated in a message to Congress in 1950,

> "I know of no loophole in the tax laws so inequitable as the excessive depletion exemptions now enjoyed by oil and mining interests.
>
> ...I am well aware that these tax priviliges are sometimes defended on the grounds that they encourage the production

of strategic minerals. It is true that we wish to encourage such production. But the tax bounties distributed under present law bear only a haphazard relationship to our real need for proper incentives to encourage the exploration, development, and conservation of our mineral resources."

More detailed criticism came in testimony by Secretary of the Treasury Snyer, who noted that depletion allowances were costing the Treasury about 500 million dollars, annually, were of little benefit to small prospectors and enabled many high income taxpayers to avoid paying any taxes.[17]

Once again, Congressional response to consideration of depletion was the addition of numerous minerals to the privileged list. The Revenue Act of 1951 raised the allowance for coal to 10%, granted a 5% allowance for sand, gravel, slate, oyster and clam shells, among others, and granted allowances of 10% and 15% to many others.*

By 1954, when the entire tax code was revised, any mineral not yet receiving some depletion allowance probably felt it was the victim of discrimination. That problem was corrected in the 1954 Tax Code, which granted depletion allowances to "all minerals" except those from "inexhaustible sources" such as the air. A distinction was also introduced for minerals extracted from foreign sources in certain cases. For example, lead, mercury, cadmium, and nickel were allowed 23% if mined from U.S. deposits but 15% if from foreign sources.

The next significant change did not occur until the Tax Reform Act of 1969. However, depletion allowances were debated on several occasions in the intervening period. In 1959, the Ways and Means Committee held a panel discussion on mineral taxation. In a brief but informative exchange, Chairman Mills raised the issue of the reasons for depletion allowance:[18]

*Added at 1951, at 5%: sand, gravel, slate, stone, brick and tile clay shale, oyster shell, clam shell, granite, marble, sodium chloride, bromine; at 10%: asbestos, brucite, dolomite, magnesite, perlite, wollastonite, calcium carbonates, magnesium carbonates; at 15%: aplite, garnet, china clay, borax, fuller's earth, tripoli, refractory and fire clay, quartzite, diatomaceous earth, metallurgical grade limestone, chemical grade limestone.

Rep. Mills: "As I understand the theory of depletion allowance, we are in this section of the law giving recognition to the fact... that we are dealing with a wasting asset. Is that the basis? ...or has the basis for depletion allowance changed in some way under our present economy to the point that we have also to consider other factors in establishing justification for depletion allowance?"

Mr. Campbell: "I would say that is still one of the main considerations. These provisions are peculiar to the extractive industries. The other consideration is that since the percentage depletion allowance as such is a substitute for the discovery depletion, there is the element of encouraging people to retain that which they found, and to operate it as a business of their own rather than to sell that which they found to someone else."

Mr. Steiner: "Mr. Chairman, I suppose everyone can have their own guesses as to Congressional intent at an earlier time. My own reading of the record shows there were repeated assertions that this program in 1918 was designed not because these were wasting assets but because of the need to stimulate their production."

Other economic justifications for depletion allowances were also discussed:

Mr. Menge: "I would like to add that the extractive industries are not the only ones which spend large sums that are not immediately realized...there is also not the basic research and development, much of which may result in products of no marketable value whatsoever..."

Mr. Jackson: "We have the same type of research expenditure as the chemical industry does. We are researching all the time for improved beneficiating processes...we have that same type of research, but we also have in addition - and no industry except the mining or extractive industry has it - the expenditures for exploration, of looking for our raw materials, and that is quite different from the non-mining industries."

Mr. Lambert: "I would agree there has been a reallocation of resources [as a result of depletion allowances], but I maintain it has been desirable, and that is what has built our country great with the low energy cost...a chart illustrates very strikingly the ratio of energy consumption to income in various countries of the world...The countries with the lowest energy utilization are the countries with the lowest income."

In 1960, the Democratic Party platform indicated that if elected, John Kennedy might repeat efforts by past Democratic administrations to end depletion allowances. A reference was made to depletion as being "among the more conspicuous loopholes," which the Party vowed to end. However, during the campaign Kennedy spoke about the depletion allowance in favorable terms.[19]

> "The depletion allowances which affect over 100 items should be considered primarily as a matter of resources policy and only secondarily as a tax issue. Its purpose and its value are first of all to provide a rate of exploration, development and production adequate to our national security and the requirements of our economy. ..The oil depletion allowance has served us well by this test."

Several amendments were introduced in the Senate in 1962 seeking to limit depletion allowances. One would have gradually reduced the allowable percentage for petroleum to 20%. Another, introduced by Senator Douglas, would have introduced a graduated scale for depletion allownaces that varied with the income of the corporation. Senator Douglas argued that this system would protect the "Daniel Boones" of the industry against the large producers. Neither amendment passed. Opponents of depletion frequently cited a recent study by Professor Harberger, who concluded that "More oil can indeed be obtained by tax concessions...(but) if the rest of the economy wants more oil, it should be willing to pay for it by way of a higher market price." While the amendments focused on oil depletion Senator McGee warned that "A Senator who votes for this amendment should keep in mind the extent to which he could be jeopardizing the future of the leading mineral industries of his home state, whether his state produces lead, zinc, copper, iron ore, granite, asbestos, or whatever."

Senator Douglas and other ardent "tax reformists" did not argue directly with predictions about the likely consequences of eliminating depletion allowances. Rather, they focused on depletion because of the magnitude of the tax benefit it provided. Depletion allowances were "the citadel of privilege", and therefore the fight for its reduction was symbolic of the entire fight for tax reform. Senator Douglas, for example, stated on the

Senate floor:

> "Mr. President, it is solemn truth that the depletion allowance should be greatly reduced. We are going to be beaten tonight; but in God's good time we will not be beaten, and the powerful oil interests which have their representatives on this floor, . ..and who will be victorious this time, in due course will not be victorious, because they are defending something which is morally and economically wrong."

Depletion allowances were again subjected to extended discussion prior to the Tax Reform Act of 1969. While perhaps less eloquent than Senator Douglas, critics of depletion were better prepared to argue the merits with their opposition. The improved political climate for tax reform may also have lessened the need for dramatizing the issue. For example, Representative Meeds stated before the Committee on Ways and Means,

> "The risks referred to (in mining) are limited to exploration, for the expenses involved in the development of the site are quite predictable. But even exploration can be predicted. We can see from statistics that giant corporations dominate, the field. It is an economic fact that risks become more regularized and predictable as the area and time span of operation increases...
>
> The oil and mining industries often argue that their capital is used up, never to be replaced, . ..More accurate analysis would say that the oil and ore is really being removed from inventory and being placed in a saleable form... If we think of oil and ore in the same light as land, their production is not a piecemeal realization of a capital expenditure, but like real estate, a barrel-by-barrel production of ordinary income, for the sellers are in the business of digging up and selling oil and ore... The percentage depletion allowance lessens our defense capability because our mineral and oil resources must be exploited before the deduction is allowed...A fourth argument by the proponents is that percentage depletion is an aid to the financing of discovery. But is this so? The deduction is not given when the mineral is <u>discovered</u>, but only when it is <u>dug</u> or <u>pumped</u> from the ground."

Meeds also accused percentage depletion of misallocating resources, aggravating inflation, damaging the integrity of the tax code, and costing the taxpayers over a billion dollars.[20]

One interesting suggestion raised during the hearings was the possibility of reverting to discovery depletion. Mr. Wilson, a former petroleum engineer testifying at the hearings, responded that valuation within a 6 month period "is virtually impossible within the limits of accuracy needed for this type of determination." While this suggests that the accuracy of the percentages established by reference to experience under discovery depletion is open to question, petroleum officials also insisted that discovery allowances would actually be higher than existing rates. (Mr. McClure, President of the Petroleum Association of America, estimated that discovery values now would be 34% or 35% of gross income based on "rather extensive review." p. 3185[20].)

Whether due to improved criticism or the change in political climate, the Tax Reform Act of 1969 reduced the percentage depletion allowances for several categories, the first such reduction in the history of depletion provisions. The rate of depletion for oil and gas was lowered from 27½% to 22%, and minerals which had received 23% were also granted 22%. Minerals at 15% were reduced to 14%, except for domestic gold, silver, copper, iron ore and oil shale, which were felt to be in critically short supply. However, special favoritism was not entirely absent; molybdenum, which had received a 15% allowance, was increased to the 22% category.

THE INFORMATION GAP

The assumption is sometimes made that because Congress has continued depletion allowances for so long there must be good reason for it. For example, Representative Boggs stated during the panel discussions in 1959,[21 22 23]

> "Do any of you attribute any significance to the fact that each time Congress has studied this problem, we have reaffirmed the necessity for this concept of the law, and have actually extended it? Would this not indicate that despite the heat with which it has been attacked from all sorts of sources, there must be a tremendous amount of merit to this concept of the law?"

While it is unlikely that this argument is made very seriously, it does seem important to emphasize the lack of information on the costs and benefits of continuing depletion allowances. Reference has already been made to the analytical weaknesses of setting rates for percentage depletion based on discovery values that were themselves felt to be excessive. (Lerner[4], p. 35; Agria[8], p. 81.) This fact alone casts serious doubt on the justifiability of percentage depletion rates.

However; the problem goes deeper than the use of arbitrary values from the discovery depletion era. For most minerals on the depletion list (all those added after 1932), no studies were even attempted to determine appropriate depletion allowances. The studies that were undertaken are also of questionable value by today's standards. Lerner[4], writing in 1952, questioned the reliability of those early examinations of depletion (p. 36).

> "The mere fact that a certain level of allowance has prevailed for a long time does not in itself mean that such a level is correct. In recent years there has been frequent reference to various studies of depletion made in the late 20's and early 30's which alleged equivalence between percentage and cost depletion. The plain fact of the matter is that those studies were by no means reliable, and the passage of time cannot confer validity upon findings which were incomplete or inaccurate. Recent studies in the measurement of excess depletion allowances, such as those by the Treasury, including those submitted to the President's Materials Policy Commission, suffer from certain obvious technical difficulties.."

Another information gap exists as to the relative costs and benefits derived from depletion allowances. This problem was raised during the 1959 panel discussions: (Appendix B, p. 512, 535.)[18]

> Mr. Galvin: "...some rather detailed objective study must be made of economic data to show what the public benefit is from depletion, and to show that benefit in relation to costs so that we could know once and for all whether the method that we are using here really causes the reallocation that we want to cause."

> Mr. Steiner: "...It seems to me that, following up with what Mr. Galvin said earlier, here is the crucial question on which we need facts: Just how much difference does this make? And... how important is this to our national defense? I think this is a question we on the panel cannot answer. If we are buying reserves we do not need, the benefits will be low. If we are buying reserves that are critical to our survival, the benefit is very, very large."

Some studies have been done in this area since then, particularly with respect to the petroleum industry,[24] but the information available on most minerals is still totally inadequate. The existing state of affairs was well summarized by Willis Snell, a participant in a Ways and Means Committee panel discussion in 1973:[25]

> "It must be emphasized that, at least for hard minerals, we have little statistical or other data on the basis of which to judge the actual effect of percentage depletion... So far as I am aware, there is no published information as to its actual economic impact on any branch of the hard mineral industry....We do not have accurate or current information as to how much percentage depletion has been allowed to producers of any given mineral, let alone how that allowance compares with the discovery or capital value of the mineral, or the effect of the 50% of taxable income limitation, either in terms of the number of miners affected or the dollars of tax deductions lost because of it."

The question of the probable effects on prices of eliminating depletion allowances is a particularly important one. Yet even the American Mining Congress was unable to offer an estimate of the likely price effects of eliminating depletion allowances on one mineral, iron ore: (p. 2205.[25].)

> "Loss of the depletion allowance would result in substantial increases in the prices of iron ore and the products made from iron ore. Unfortunately, we are not in a position to quantify this answer. To do so would require assumptions (1) as to the elasticity of demand at a given point in time and a given point on the demand curve, (2) as to the pyramiding effect of increases in iron ore prices at subsequent levels, (3) as to the long-run effect on the direction of investment funds into the industry, and (4) as to the treatment of depletion allowances on other mineral products that are actual or potential substitutes for iron products."

The lack of certainty as to effects on prices and profits is one argument industry representatives give in opposition to allowing higher prices as opposed to lower taxes as a way of inducing investment in minerals. One petroleum official argued before the Ways and Means Committee that “price does not operate fast enough" and the prospect of lower profits for at least the short run would seriously damage investment prospects in the industry. (Richard Gonzalez[25], pp. 1462-64.)

The ultimate impact of this information gap on policy making is itself a political judgment. Industry spokesmen argue that any provision of the tax code as deeply entrenched as depletion allowances should be continued until critics prove that changes will not be harmful.[26] On the other hand, opponents of depletion argue that industry is in the best position to supply the necessary data[27] and that there is sufficient understanding of the depletion allowance to know it serves no useful purpose. (Mr. Gray[18], p. 505.)

DEFINITION PROBLEMS

The substitution of percentage for discovery depletion ended the judgmental problems involved in evaluating the worth of mining discoveries. However, a host of difficult administrative problems remained, and many new ones were created as additional minerals were added to those already allowed depletion. For purposes of providing an overview of these administrative problems, four problem areas will be discussed. However, the reader is warned that an in-depth consideration of these issues is outside the scope of this paper; the technical questions surrounding the operation of the depletion provisions are the source of employment for many tax lawyers.

(1) "Minerals"

Section 613 lists various minerals and the allowable rates of depletion. However, neither the Code nor, with a few exceptions, the Internal Revenue regulations provide chemical definitions of the various "minerals". A somewhat bizarre example of the possible issues raised by this section is the case of a taxpayer who attempted to take depletion on the skills of his employees. A court ruled that such skills were not within the meaning of "other natural deposits" entitled to a deduction (Heisler v. U.S., 463 F.2d 375; 9th Cir. 1972.).

An example of a more frequently encountered problem is the definition of quartzite, a term used to describe certain varieties of stone, but not always with the same meaning. The distinction is important since quartzite is allowed depletion at a rate of 14% whereas most other forms of stone are allowed only 5%. Similarly, a rather ephemeral boundary distinguishes limestone, depletable at 15%, from calcium carbonate, which is entitled to only 10%.

Another problem with potential relevance to recycling arises from the extraction of minerals from tailings or waste piles. In general, depletion of waste materials (other than cost depletion for the purchaser of such materials) is allowed only in narrowly circumscribed instances. Until 1960, the position of the I.R.S. was that a waste pile would only be considered a "mine" for purposes of depletion allowances if processing the waste was an integrated step in the mining operation.[28] However, the 1954 Code included an amendment specifically allowing income from the extraction of minerals from prior mining activities to be included within gross income for depletion. The waste materials can be from treatment processes or the original extraction, but in either case the reworking must be done by the owner of the natural deposit.

Since minerals derived from waste piles contribute to total resources just as much as those extracted from natural deposits, the existing restrictions seem unfairly discriminatory. This approach may have been justified when depletion was based on discovery, but even under that system tax benefits could only be derived from the sale of minerals. One tax court decision opened a small crack in the I.R.S. regulation by allowing depletion of a dump being reworked for minerals different than those originally mined. In such circumstances, the court found, the dump had not lost its character as a "natural deposit". (Pacific Cement & Aggregates, Inc., 31 T.C. 136). However, the I.R.S. has not acquiesced in the court's decision.

(2) Economic Interest

Under a decision of the Supreme Court and I.R.S. regulations (1.611-1b) depletion deductions are allowed only to the owner of an "economic interest" in a mineral deposit. The problem arises when the original owner of a mine contracts with another for its development. Unless the owner transfers his interest, both parties will have income "from the property" and therefore will arguably be entitled to a depletion allowance.

After a 1918 Supreme Court decision dealing with the 1909 Act denied a deduction for depreciation to a lessee, the 1918 Act and every revision thereafter included the statement that "In the case of leases the deductions allowed by this paragraph shall be equitably apportioned between the lessor and lessee." The Supreme Court later allowed depletion deductions to be taken by lessees under earlier Acts as well, so long as the mineral interest was "acquired by investment" and the taxpayer's return on investment depends solely on production.

At various times the I.R.S. has attempted to restrict the availability of depletion allowances to certain arrangements. For example, regulations at one time denied a deduction for income earned as a share of net profits from a mine. This position was rejected by the Supreme Court (Kirby Petroleum Co. v. Commr.,326 U.S. 599; 1946), and the prevailing view appears to be that the determination of an "economic interest" depends upon the totality of facts in each case. The Supreme Court has specified seven factors to be considered, although without indicating their relative importance; (1) the existence of an investment in the mineral deposit that will be depleted by its extraction; (2) the lack of capital investments recoverable through depreciation; (3) the contract must not be terminable at the will of the owner; (4) the transfer of a capital interest in the mineral deposit; (5) the transfer of ownership of the mineral as it is mined; (6) the right to a share of the proceeds resulting from the sale of the mineral rather than a fixed fee; and (7), the right to seek compensation other than from the landowner (Parsons v. Smith, 359 U.S. 215; 1959).

While the problem of defining an "economic interest" is usually not a major concern, at least in terms of overall mining operations, it is important for two reasons. First, it indicates the kind of administrative problems that continue to plague the depletion provisions. Second, the extension of depletion to persons who have not done any exploraton or development undercuts one of the most frequently cited reasons for granting the depletion deduction.

(3) "Gross Income from the Property"

Section 613 limits depletion allowances to a percentage of income from the mining property. (For more exhaustive treatment of these issues, see P. Schmid and D. Williams [29].) section 614 allows the aggregation of mineral properties under certain circumstances, a procedure which may allow the taxpayer to circumvent the 50% of taxable income limitation in determining allowable deductions. Prior to 1954, when section 614 was adopted, each separate interest was taxed as a unit. Now, a taxpayer with operating mineral interests in the same "operating unit" can aggregate them for tax purposes, and under certain circumstances a single interest may be treated as more than one property. Under I.R.S. regulations, an "operating unit" refers to a producing unit and not to an administrative or sale organization. Factors considered to be evidence of an operating unit are common personnel, supply facilities, processing or treatment plants, and storage facilities.[30] This provision would appear to favor the large companies, who have greater operating flexibility and are therefore more likely to meet the I.R.S.

requirements. (The use of the aggregation provisions is explained in detail, including examples of its effect on deductions in Tax Management, Worksheets, 1-3.)

Having selected a taxable unit, the next problem becomes calculating the gross income from mining. The definition of mining is a controversial subject and has spawned considerable litigation since it is in the tax-payers' interest to include as many processes as possible before calculating allowable depletion. Early Revenue Acts did not define the scope of allowable mining processes.[31] The earliest Treasury regulations, issued under the 1913 Act, defined gross income in terms of the market value of the mineral. Regulations issued under the 1921 Act refined the definition to the price of the raw material, before refining. The adoption of percentage depletion made further precision necessary and regulations issued under the 1932 Act listed specified processes which could be applied prior to computing gross income.

During World War II, when Congress added numerous minerals to the list of those entitled to depletion, an effort was made to at least partially resolve the problem of defining a cut-off between mining and manufacturing. The Revenue Act of 1943 defined mining to include:

> "not merely the extraction of the ores or minerals from the ground but also the ordinary treatment processes normally applied by mine owners or operators in order to obtain the commercially marketable mineral product or products."

Certain specifically 'eligible processes were also listed. An allowance for transportation costs up to 50 miles, or further if the Treasury ruled that moving longer distances was necessary, was added in 1950 to cover the costs of hauling minerals from the point of extraction to plants for "ordinary treatment processes".

The implementation of these provisions has probably been the greatest source of uncertainty, and undoubtedly the greatest source of litigation under the depletion sections of the tax code. The incentives for attempting to extend the cut-off point are very great; in some cases, including the additional income derived from a particular treatment process may be more important than the allowable rate of depletion. The I.R.S. attempted to devise various rules of thumb for distinguishing "mining" from other manufacturing processes. Judicial responses varied.

One test, which initially achieved some success, disallowed any process which affected a chemical change. This rule was rejected because a taxpayer was able to demonstrate that chemical processes were necessary to produce the first "commercially marketable" product from the mineral in question, calcium carbonate (Dragon Cement Co. v. U.S., 244 F. 2d 513; 1st Cir. 1957).

Until 1960, the I.R.S. had little success in the courts in restricting the scope of "ordinary treatment processes" in other than obvious cases. (The courts have been fairly strict in disallowing income received from sources other than the sale of minerals, for example from the sale of discarded equipment or business interruption insurance.) The prevalent judicial attitude was reflected in a "profitability" test, which viewed any process necessary to produce a commercially marketable product as a "mining" process for purposes of depletion (e.g., Iowa Limestone v. Comm., 269 F. 2d 398; 8th Cir. 1959).

In 1959, hearings were held on possible legislative revision of the definition of mining. The Treasury Department submitted a proposal to eliminate the commercial marketability test, indicate specific processes entitled to depletion, and specify a cut-off point beyond which further processes would not be considered mining. (Agria[8], p. 87.)

Legislative action was delayed pending the outcome of a Supreme Court case reviewing an appellate court decision that adopted the "profitability" test. In Cannelton Sewer Pipe Co. v. U.S., 364 U.S. 76 (1960), the Court rejected the theories developed by the lower courts. The primary inquiry was at what point the ordinary miner (as opposed to the integrated miner-manufacturer) shipped his product. If all the producers in the relevant market were integrated, an estimation of the proportion of income from the first marketable product was necessary even if the first marketable product could not be sold profitably. Later court interpretations went even further, finding that the lack of a market for the mineral in its raw state did not extend the scope of allowable mining processes.[32]

The Congressional response was to adopt the basic ideas suggested by the Treasury Department. The old definition of mining was deleted and specific cut-offs for some minerals were added. Additional flexibility was added by giving the Treasury the authority to add other processes. The general theory behind the choice of specific processes was that "mining" should include processes necessary to prepare the mineral for sale prior to refining. Thus, the separation of waste material from.the raw mineral is subject to depletion, but the introduction of any chemical changes is not. While not as drastic as the approach taken by the Supreme Court's Cannelton decision, the amendment did reverse the trend toward increasingly liberal interpretations of mining processes.

One issue left open by the 1960 legislation is whether the use of a non-mining process establishes a cut-off point beyond which otherwise acceptable processes must be considered nonmining. The I.R.S. regulations adopted this "sudden death" approach with an exception for the use of nonmining processes "necessary of incidental to" a mining process, or where application of the rule would discriminate between similarly situated producers.[33] The need for continued case by case analysis seems apparent. however, one optimistic commentator has suggested that "the major controversies have been resolved" by recent I.R.S. regulations.[34]

Numerous other questions have also arisen in the determination of gross income limitations. The infinite variety of transportation arrangements, for example, require considerable administrative review despite the general rule allowing profits for haulage to a treatment plant within 50 miles of the point of extraction.[35] Similar administrative problems also arise in deciding whether profits from bagging and packaging are allowable.

The payment of royalties also creates problems for the I.R.S. The courts have firmly upheld the right of the I.R.S. to exclude from gross income any fees paid as a fixed amount per unit of production or as a percentage share of net profits (e.g., Burton-Sutton Oil Co. v. Commr., 328 U.S. 25; 1964). The problem can be much more subtle, however. For example, the I.R.S. has also excluded the payment of taxes by a lessee on behalf of a lessor from gross income on the premise that such payments constitute a substitute for higher rent.

Another major source of difficulty is the allocation of income between mining and nonmining activities. Vertically integrated manufacturers must compute a representative market price for the minerals used in their production processes before apportioning income between mining and nonmining activities. When a representative field price is not available, regulations generally require the application of a proportionate profits method to determine the percentage of income generated by each stage of the production process.

Recent Congressional action indicates that the question of the cut-off point between "mining" and "manufacturing" is still very much a political issue. An amendment passed October 16 allows producers of the ore trona to include income from the calcining process, a change which will increase the producers' depletion deductions by $2 million annually.[36]

(4) "Taxable Income from the Property"

After all other calculations have been made, the total depletion deduction must fall within the 50% of taxable income limitation. Since excess depletion is of no use to the taxpayer, (it is in his interest to allocate as much of possible expenses to non-producing properties or other nonmining activities). Problems frequently arise in attempting to apportion administrative and overhead costs, and the large, integrated producer has a significant advantage in being able to maneuver these expenses. I.R.S. regulations define taxable income from the property as the "gross income from the property" less allowable deductions attributable to the property, including overhead and operating expenses, costs of "mining" processes, and amounts deducted for exploration and development (1.613-5).

Taxable income from the property is limited by the amount determined to be gross income from the property, but there are many expenses which arguably bear this relationship. Over the years, courts have decided that the following expenses must be deducted from gross income in proportion to the relationship of mining costs to other activities: state and local taxes, interest paid on money borrowed to purchase the mineral property, amounts paid in settlement of silicosis claims, and losses resulting from the abandonment of mining equipment.[37] Courts have reached different conclusions on the appropriate treatment of the costs of packaging and advertising.[38]

When the taxpayer owns more than one property, expenses must be allocated to each, with a significant tax benefit being derived from the allocation of costs to the nonproducing properties which are not yet receiving a depletion allowance. The I.R.S. is in a difficult position to challenge many allocation decisons since the taxpayer's intent may be an element in the determination.

> "Take, for example, the case, of a miner who incurred exploratory expenditures because he needed to have greater mineral reserves in order to continue his operations. If his efforts were confined to determining the extent and quality of the mineral deposit which he was presently extracting, all the cost thereof would be directly attributable to that property if the survey applied only to that deposit within the area limits of his lease or land.

> If, however, the survey was for the purpose of finding distinctly separate deposits either on his lease or land or on other areas, such costs need not be used in determining taxable income from the operating property. If property were acquired as a result of such exploration and when developed it was aggregated with the presently producing property, §614 (c)(A) requires that the exploration costs would have to be deducted in recomputing the taxable income for the year of exploration for the purpose of limiting percentage depletion on the aggregated property. It is readily apparent that the question as to the taxpayer's intent in making the exploration will need a reasonable approach."[39]

Whether because of this problem of intent or other reasons, many mining firms have been extremely successful in shifting exploration and development expenditures away from the depletion account. A relative measure of success has been calculated by Page[5], who estimates that for the metals allowed 15% depletion, 98% of capital is recovered other than through the depletion account.

FOREIGN TAX CREDIT

Sections 901-905 of the Internal Revenue Code (Title 26, U.S.C.A.) set forth the basic provisions of the foreign tax credit. Within certain limitations, the foreign tax credit allows a personal or corporate taxpayer to offset his domestic tax liability on income earned in foreign countries by the amount of taxes paid to foreign governments. The usual rationale offered in defense of the credit is that:

> "If both countries with a claim for taxing a particular transaction were to impose their tax without regard for the other, the result would be double taxation with burdens that would deter international business. Indeed, it would be possible, in the absence of accommodation mechanisms, for tax burdens to exceed 100 percent of the income earned. The foreign tax credit is the basic mechanism by which the United States accommodates its tax system to that of foreign jurisdictions. If there were no foreign tax credit, American companies in many instances would have no practical alternative to divesting themselves of their foreign operations." Stanford G. Ross, in General Tax Reform, Panel Discussions before the Comm. on Ways & Means, House of Representatives, 93rd Congress, 1st Sess. (Part 11) (1973), p. 1725.

HISTORY

The original Internal Revenue Act of 1913 allowed foreign income taxes to be deducted but not credited. Foreign taxes were treated like any other business expense. The Treasury Department also adopted a policy of deferring the imposition of taxes on income earned by foreign subsidiaries until repatriated as dividends, a decision almost as significant as granting the tax credit.[39]

The increase in foreign tax rates that accompanied World War I resulted in pressure on Congress to eliminate the harshness of "double taxation". Congress responded favorably and included a foreign tax credit in the Internal Revenue Act of 1918. The credit was to be limited to "income and profits taxes" as opposed to royalties or other business expenses, a distinction that has been the source of much litigation. A major question was resolved when the courts determined soon after the Act's passage that the credit was to be allowed for applicable foreign taxes, even if contested or not yet paid.[40]

The Revenue Act of 1921 sought to prevent corporations from using their foreign tax credits to offset domestic tax liability. An overall limit was added to prevent this abuse. Further restrictions were added in 1932; a per country limitation was added and taxpayers were (only allowed to credit the lesser of the overall limitation or the per country), In addition, a provision was added disallowing any deduction for the excess of foreign taxes over permissable credits.

The credit was subjected to a major attack in 1934 when a subcommittee of the House Committee on Ways and Means recommended that foreign income taxes be allowed only as a deduction. The subcommittee report concluded that "The present provision discriminates in favor of American citizens and domestic corporations doing business abroad as compared with those doing business in this country." The unfairness of not allowing a similar credit for state and local taxes was specifically noted. Despite agency interests which usually seek to increase tax revenue, the Treasury Department representatives testified in opposition to the measure:

> "In the judgment of the Department the present arrangement seems fair and should be continued. If it is not continued, American taxpayers doing business abroad will have an additional incentive to organize foreign corporations to take over their foreign business, with resultant loss of both business and revenue therefrom. It is quite clear that the elimination of the foreign tax credit will not increase the revenues to the extent of the taxes which American taxpayers now save by virtue of it. The amount in any case, however, is relatively small....For 1933 the total of foreign tax.credits is estimated at not to exceed $8,000,000." Revenue Revision, Hearings before the House Comm. on Ways & Means, p. 78 (1934).

Treasury recognized the inequity involved in the dissimilar treatment accorded state taxes. However, the Department report argued that "The fact that this duplication already exists in this country is not a satisfactory reason for increasing the duplication in other directions."

The subcommittee proposal was also vigorously challenged by industry representatives. An official from the American Mining Congress noted that elimination of the credit would necessarily hinder foreign trade, and warned: "It of course follows that any serious decline in foreign trade would have an unfavorable reaction on our employment situation and the general prosperity of the country."[41] As evidence, the mining official cited a Commerce Department report which calculated that U.S. exports were responsible for employment for 2,400,000 families, with probably a like number employed in related industries.

The final House report compromised by seeking to cut the credit in half. The entire idea was rejected in the Senate and dropped from the final bill.

Several provisions in the Revenue Act of 1942 broadened the scope of the credit. First, the definition of "income tax" was expanded to include certain taxes in lieu of income taxes. Second, corporations were granted the right to credit the taxes paid by a foreign subsidiary (subject to the per country and overall limitations). Third, a requirement that the taxpayer elect in advance whether to credit or deduct foreign taxes was eliminated. The motivation for these liberalizing amendments was apparently the "extremely high rates of taxation" imposed by several governments during World War II, which caused considerable hardship for some American corporations.[42]

The appropriate method of computing a limit on tax credits was reconsidered in 1954. On the recommendation of the Treasury Department, the overall limitation was repealed and the per country limitation required. This provision was amended again in 1960 when taxpayers were given the option of either the overall or per country limitation. While this eventful history may be no more than the result of changing political fortunes (allowing an option is the most advantageous provision for the taxpayer), the two alternatives do serve different policy concerns: [43]

> "The overall limitation reflects a view that all foreign income should be lumped together and all foreign taxes allowed to apply against United States taxes on all foreign income. The notion behind this limitation is that the individual foreign countries where income is earned and their taxing systems are not particularly important.from a United States taxing standpoint....The per-country limitation reflects a view that our rules should treat separately each particular foreign jurisdiction where income is earned or a loss is incurred. . ..This may be seen as a more neutral tax principle since a taxpayer contemplating a foreign investment must estimate the combined United States and foreign tax results solely in terms of the interaction of the taxing systems of two countries." Stanford G. Ross, p. 1726.

The Technical Amendments Act of 1958 added a 2-year carry-back and 5-year carry-forward for credits in excess of permissable amounts in any given tax year.

In 1961 the Kennedy administration advocated elimination, or at least restriction of deferral privileges as a way of regulating the growing number of tax havens in countries with low tax rates.[44] The problem was that a U.S. company could form a holding company in a country with low tax rates to receive income from operations in other countries and through foreign reinvestment avoid U.S. taxation indefinitely. Devising workable legislation, however, proved to be extremely difficult because of the definitional problems involved in distinguishing "tax havens" from "legitimate" foreign enterprises.

The legislation that finally emerged, subpart F, was the result of some

Congressional compromise. The House bill would have gone far toward elimination of deferral, while the Senate would have made no change. The compromise worked out in conference, subpart F, is one of the most complicated provisions in the entire tax code. The basic scheme works as follows:

> "Essentially, these provisions impose U.S. tax currently on the undistributed foreign base company earnings of a foreign corporation controlled by U.S. stockholders. They also tax to the U.S. shareholders any earnings of a controlled foreign corporation reinvested in United States property. There are several exceptions to imposition of the subpart F tax. One of these is the so-called '70-30' rule, under which, if foreign base company income is less than 30% of gross income, none of the income is currently taxable...Under the "minimum distribution" exemption, . ..subpart F tax may be avoided if the foreign company makes current distribution to its U.S. stockholders, the tax on which, when combined with the effective foreign rate on undistributed earnings, equals 90% of the U.S. 48% rate on the combined earnings." Thomas Jenks, in General Tax Reform, p. 1741

In 1966, an amendment was passed allowing an alien resident the right to use the foreign tax credit. Previously, an alien resident was only allowed to use the credit if his home country granted a similar right to U.S. citizens. However, the President was given the authority to reinstitute the restriction by designating specific countries, and the old provision still applies to income earned by foreign corporations and non-resident aliens.

The most recent amendment to the foreign tax credit came as part of the Tax Reform Act of 1969. Prior to 1969, multiple tax benefits were possible on foreign mineral income; a corporation could receive a depletion allowance based on a percentage of gross income which included foreign income taxes.[45] This possibility was limited, although not totally eliminated, in the Tax Reform Act. Under section 901(e), foreign taxes on mineral income at higher than U.S. rates are not allowed as credits to the extent attributable to percentage depletion. (That is, they cannot be averaged out with lower taxes on non-mineral foreign income under the per-country limitation or with income from other countries under the overall limitation). However, a double benefit is still possible when the credit does not exceed the amount determined by U.S. tax rates.

RELATED PROVISIONS

Several other provisions of the tax code are also of potential benefit to U.S. firms undertaking mining activities in foreign countries.[46] Special tax treatment is accorded businesses which organize as Western Hemisphere Trade Corporations, Less Developed Country Corporations, or U.S. Possession corporations, provisions directed toward encouraging business development in specific parts of the world Similar tax benefits are also available to corporations incorporated under the China Trade Act of 1922. In order to grant exporters some of the same tax incentives given foreign investors legislation was passed in 1971 creating Domestic International Sales Corporations.

CURRENT DEBATE

A panel of experts discussed "Taxation of Foreign Income" before the House Committee on Ways and Means during 1973. Many issues were raised, but the two questions most hotly debated were the need for further restriction on deferral and the value to the economy of continuing the foreign tax credit. The intensity of the debate may reflect the magnitude of the stakes; deferral represents a savings of up to $1 billion, and before-tax profits on U.S. foreign investment were about $18 billion in 1970, 20% of the total profits of U.S. corporations.

EXPENSING OF EXPLORATION AND DEVELOPMENT COSTS

The mineral industry receives significant tax benefits from the expensing of mining exploration and development costs. Sections 616 and 617 of the Internal Revenue Code allow the taxpayer the option of "expensing" costs of mining exploration and development, that is, deducting them in the year incurred rather than through capitalization and gradual depreciation. This deduction is only granted for expenditures that would not otherwise be entitled to a deduction, and is also not allowed for purchases of depreciable property (or the costs of acquiring such property).

The primary advantage of these provisions is one of timing:

> "The privilege of expensing allows a hard mineral firm to take deductions earlier than would be the case under the concept of depreciation, which would match the deductions against the flow of income. Taking deductions sooner has the effect of pushing tax payments off into the future. This is equivalent to an interest free loan from the Treasury for the amount of the tax deferred and for the same length of time that the deduction would have been taken in the absence of the expensing privilege....And with inflation, an interest free loan is made more attractive by the amount of the rate of inflation."

A. DEDUCTION IN OPERATION

Capitalization and depreciation are the usual methods prescribed by the tax code for deducting costs of tangible property with a limited useful life (§167, 1002, and 1016). These provisions still apply to mining costs, including exploration and development. However, a large proportion of exploration and development expenses are for non-depreciable items such as labor, testing of samples, and construction of access tunnels.

The percentage of exploration and development costs which benefit from this provision does not appear to be available, although one can imagine only rare circumstances in which the taxpayer would not want to use it. Page estimates that as a general principle, the mineral industries have been very successful in avoiding capitalization of the costs of mining.

(See Page, pp. 12-16) One source estimates that intangible non-depreciable expenses amount to around 75% of the cost of drilling and development for oil and gas. (Hambrick, in General Tax Reform Panel discussions, p. 1370.) The usual tax theory for treatment of this type of business 'start-up' cost is that such costs should be deducted over time to match the flow of income generated by the mine. (This option is still available to the taxpayer.) Until 1951, this was the accepted method for deducting these expenses.

Expensing is much more generous. Section 617 allows the taxpayer an unlimited deduction for the mineral exploration costs discussed above (other than for oil and gas wells) if spent in the U.S. Deductions for exploration outside the U.S. are limited to $400,000, taking into account any deductions for deposits in the U.S. (including deductions in prior years). The deductions are, however, subject to "recapture", i.e., the amount of income shielded by the deduction is eventually subject to taxation when the mine reaches the producing stage.. (A mine is considered to have reached the producing stage when "the major portion of the mineral production is obtained from workings other than those opened for the purpose of development, or when the principal activity of the mine is the production of developed ores or minerals, rather than the development of additional ores or minerals for mining." House Rep. No. 1237, 89th Congress, 2d Session, p. 9.) This comes about in one of two ways at the election of the taxpayer: (1) the exploration deductions are added to the income from the mine, or (2) depletion deductions from the property in the amount previously expensed are foregone. (The amount added to income or subtracted from depletion deductions is adjusted to reflect any reductions in prior depletion allowances caused by the §616 and 617 deductions. See Reg. §1.617-3). Under the first alternative, the amount recaptured is added to the basis in the property so that the taxpayer is in the same position he would have been had the costs been capitalized originally. If the property is sold or otherwise disposed of before exploration expenses have been completely recaptured, the taxpayer will recognize additional gain. (See Merten's,[1] Ch. 24, pp. 53-54, and Reg. 1.617-4.)

The deduction for mining development is provided in §616. The "development" stage includes expenditures made "after the existence of ores or minerals in commercially marketable quantities has been disclosed" (and therefore extends to some production costs as well; See Reg. §1.6161 (a).) The deduction, like that for exploration costs, is limited to expenditures for non-depreciable property which are not otherwise deductable, and the taxpayer may elect to capitalize the expenses and deduct them rateaibly as units of produced minerals are sold. (During the development stage, the deferment option only applies to the excess of expenditures over net receipts from the deposit. Unlimited deferment is permitted during production. See Reg. §1.616-2.).

Sections 616 and 617 apply to all minerals entitled to percentage depletion except for oil and gas. Oil and gas taxpayers are less favorably treated. Under §263(c), a deduction may be taken for intangible drilling and development costs of oil and gas wells. The deduction is not available for exploration costs, except where drilling is involved. Section 263 also does not provide the option of deferring the deduction and taking it as a prepaid expense when production begins, a valuable option when expenses exceed the taxpayers income from other sources. The mining taxpayer is also allowed to choose between expensing and deferring the deduction on an annual basis, whereas the oil and gas taxpayer must make one binding election between expensing and capitalizing.

B. DUPLICATION OF BENEFITS THROUGH DEPLETION

Reference has already been made in the Depletion section to the possibility of a "double deduction" for certain expenses because of the overlap of depletion and expensing allowances. This comes about because depletion, unlike the depreciation method allowed other industries, is not based on actual cost. In industries restricted to depreciation, allowing an expenditure to be expensed means an equivalent reduction in allowable depreciation. The mineral industries, because percentage depletion continues even when deductions are in excess of actual expenditures, do not lose anything by expensing. In effect, every dollar expensed represents a net gain to the industry, subject only to the possible limits imposed as a result of the. 50% of net income restriction on depletion allowances. (Exploration expenditures are only deducted from net income for purposes of the 50% of net income limitation on depletion allowances when such expenditures are "from the property" being depleted. This sometimes gives the taxpayer added room to attempt to increase his allowable deductions.)

The same incentives, exist for mineral industries to seek separate depreciation deductions for capital investments related to the mine. For example, if the cost of a drilling machine is added to the capitalized value of a mine, the taxpayer gains nothing since the additional cost does not increase allowable depletion allowances. But if the taxpayer is allowed depreciation deductions on the machine, his total deductions will increase. Courts have been fairly generous in this regard, allowing depreciation of any asset which has a measurable life of its own apart from the mineral deposit. (See, e.g., Amherst Coal v. U.S., 295 F. Supp. 421; D.C.W.Va. 1969;)

C. LEGISLATIVE HISTORY

The mining industries were not given the option of expensing exploration and development expenditures until 1951. Prior to that time, such expenditures had to be capitalized; However, the oil and gas industries were allowed to expense intangible drilling and development costs much earlier.

The option of expensing for oil and gas taxpayers originated with a Treasury Decision in 1917. T.D. 2447 granted taxpayers the option of deducting, "as an operating expense," "the incidental expenses of drilling wells, that is, such expenses as are paid for wages, fuel, repairs, etc...." The reason for granting this option is somewhat obscure. One authority suggests,

> "There was apparently a feeling among accountants at that time that while the tangible costs clearly had to be capitalized and depreciated, the intangible costs had to be expensed. . .A number of requests were made to the Bureau of Internal Revenue for permission to capitalize intangibles. The officials were an obliging lot, and they decided to permit that 'option'." J. Hambrick, in General Tax Reform Panel Discussions, p. 1371 (1973).

T.D. 2447 was continued in future Treasury regulations. At first, the option was only available to owner-operators, but it was soon extended to lessees as well. The Treasury Department attempted to eliminate the privilege in 1942. However, because the provision had been in force for so long, the Department felt that any change would require legislation (a position suppported by some court decisions). Congress took no action on the proposal.[47]

The first real threat to the expensing option occurred in the courts. Although the privilege was not directly at issue, a federal Court of Appeals indicated that the regulation was void as inconsistent with other tax laws. (F.H.E. Oil Co. v. Commissioner, 147 F.2d 1002; 5th Cir. 1945). The I.R.S. announced it would disregard the court's opinion, and in an extraordinary action, Congress passed a concurrent resolution declaring support for continuation of the option. '(House Concurrent Resolution No. 50, 79th Congress; for further discussion of the background of the resolution, see Lerner,[4] pp. 22-24.).

The Treasury again sought to restrict the value of the expensing provision in 1950. The Department proposed that for purposes of computing depletion "gross income" be reduced by the amount of intangible expenditures expensed. Congress rejected the idea.[48] The regulation was finally enacted into law by Congress in 1954 as **§263(c).**

While mining did not receive the same privilege for expensing intangible costs provided in T.D. 2447, the industry did receive some early tax benefits. A regulation first issued in 1921 allowed an immediate deduction for development costs up to the amount of net receipts from minerals. Additional amounts of income were capitalized. (See Korth v. Mountain City Copper, 174 F.2d 295; 10th Cir. 1949).

In 1951, Congress adopted the forerunners of sections 616 and 617. Development expenditures were given the same status they have under the present tax code. Exploration costs, however, were treated somewhat differently. The taxpayer was allowed to expense up to $75,000 a year in any 4 years, or a maximum of $300,000. This amount was not subject to recapture.

The Senate Finance Committee gave the following explanation for allowing the expensing of exploration expenditures:

> "It is generally recognized that the present available mineral resources of this country are in many respects deficient in view of the ever-increasing demands of our economy, especially in an emergency period such as the present...Intensified and expanded efforts to find new deposits of ores and other minerals are highly desirable.
> ...
> Your committee believes that a special incentive for increased exploration for mineral deposits is desirable, especially in the case of taxpayers with limited financial resources."

The Committee's explanation is most interesting for its‘implicit admission that depletion allowances were an inadequate stimulus to exploration for minerals. Depletion was frequently defended on that ground. Of course, other reasons may also have entered into the decision. The political climate for legislation favorable to the mineral industry was excellent in the early 1950's, and the adoption of expensing may have been just another tax break. Congress was probably also influenced by the existence of the intangible drilling and development deduction for oil and gas taxpayers.[49]

In 1954, Congress amended the exploration expenditure deduction (§615) to allow up to $100,000 for four years. The next point of attack was the four year limitation. Critics pointed to the discrimination against smaller producers who were unable to benefit from the entire $100,000 allowance in one year.[50] In response to this problem, the four year limitation was eliminated in 1960.

Section 617, the provision that now governs all exploration expenditures, was adopted in 1966 as an option to the limited deduction (without recapture) offerred by §615. The Senate Report gave the following explanation for the new alternative:

> "For the many taxpayers who had already reached the $400,000 limit in exploration expenditures, the incentive to continue mining explorations was substantially reduced. Not only do they lose the tax advantage of the immediate write off of these exploration costs, but also in the case of exploration expenditures which prove unsuccessful they were likely to forego the recovery of these costs for almost an indefinite period." (Sen. Rep. No. 1377, 89th Congress, 2d Session).

The Report also noted that the inclusion of a recapture provision was necessary to avoid aggravating the problem created by giving taxpayers deductions from ordinary income for amounts subsequently taxed as capital gain.

The most recent amendment was made in 1969. The option of a limited deduction without recapture was eliminated for subsequent years. Section 617 now provides the only deduction for exploration expenditures.

D. CURRENT DEBATE

Recent hearings on the tax treatment of the mineral industries have given surprisingly little attention to the expensing provisions. Critics are most concerned by the "double benefit" problem. This situation could be remedied without changing the expensing deductions by an amendment requiring that any costs expensed be deducted as allowable depletion.[51]

The reason for the lack of significant opposition may be the similarity between Sections 616 and 617 and other provisions of the tax code allowing accelerated depreciation or amortization. The concept of delaying taxes to achieve desired social ends may be too well engrained to be challenged in the context of any one industry.

However, the same cost and benefit questions raised regarding depletion could also be asked of the expensing provisions. Assuming expensing does serve to facilitate desirable increases in mining exploration and development, the taxpayer is still entitled to ask whether the same benefits might be achieved through less expensive means.

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St. Mary's Oil and Gas Corp. v. C.I.R. 42 B.T.A. 270 (1940);
Montrea Mining Co. v. C.I.R. 41 B.T.A. 338 (1940);
Elk Lick Coal Co. v. C.I.R. 23 T.C. 585 (1955).
38. See Tax Management, pp. A-50 to A-53.
39. Peggy Musgrave estimates that deferral reduces U.S. tax revenues by up to $1 billion. General Tax Reform, Panel Discussions before the Comm. on Ways and Means, House of Representatives, 93d Congress, 1st Session, Part 11, pp. 1755-56. See also comments of Stone, p. 1386, and Jenks, pp. 1738-42. (Hereinafter cited as General Tax Reform).
40. See Merten's[1], Law of Federal Income Taxation, Vol. V. Sec. 33.01.
41. Fernald, Henry B. In: Revenue Revision: Hearings before the Comm. on Ways and Means, House of Representatives, 1934, p. 389.
42. Senate Report No. 627. The Revenue Bill of 1943. p. 64.
43. See also Jenks, pp. 1743-44.
44. The description that follows is based on the accounts given by Ross, p. 1724; Jenks, pp. 1738-42; and Glassman, Part 11, pp. 1706-10, in General Tax Reform.
45. For examples, see Hambrick, in General Tax Reform, Part 9, pp. 1373-75.
46. The merits of these tax benefits are thoroughly debated in General Tax Reform, Part 11. See Glassman, pp. 1730-32; Jenks, pp. 1746-49; Musgrave, pp. 1756-58; and Stone, pp. 1838-41. Debate on these issues appears on pp. 1860-62 and 1876.
47. Agria[8], p. 90
48. Ibid.
49. This reasoning is supported by the Committee's explanation for

allowing expensing of development expenditures: "It is believed that the expenditures for the development of a mine...are essentially similar to those incurred after the production stage has been reached, and like those, should be treated as expenses relating to the production of the ore or minerals."

50. See Merten's[1] Chap. 24, pp. 309-310.

51. See Statement of J. Hambrick, in General Tax Reform Panel Discussions, p. 1371.